# OUTCOME ANALYSIS OF CROSS PINNING VERSUS LATERAL PINNING IN SUPRACONDYLAR FRACTURES OF HUMERUS IN CHILDREN

***Dissertation submitted for***

**M.S. DEGREE (BRANCH – II – ORTHOPAEDIC SURGERY)**


**THE TAMILNADU DR. M.G.R. MEDICAL UNIVERSITY**
**CHENNAI, TAMILNADU**

**APRIL – 2014**

# CERTIFICATE

This is to certify that this dissertation titled **"OUTCOME ANALYSIS OF CROSS PINNING VERSUS LATERAL PINNING IN SUPRACONDYLAR FRACTURES OF HUMERUS IN CHILDREN"** is a bonafide record of work done by **Dr.R.SENTHIL KUMAR,** during the period of his Post graduate study from May 2012 to November 2013 under guidance and supervision in the Institute of Orthopaedics and Traumatology, Madras Medical College and Rajiv Gandhi Government General Hospital, Chennai-600003, in partial fulfillment of the requirement for **M.S.ORTHOPAEDIC SURGERY** degree Examination of The Tamilnadu Dr. M.G.R. Medical University to be held in April 2014.

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# CERTIFICATE

This is to certify that this dissertation in **"OUTCOME ANALYSIS OF CROSS PINNING VERSUS LATERAL PINNING IN SUPRACONDYLAR FRACTURES OF HUMERUS IN CHILDREN"** is a bonafide work done by **Dr. R.SENTHIL KUMAR** under my guidance during the period 2012–2013. This has been submitted in partial fulfilment of the award of M.S. Degree in Orthopedic Surgery (Branch–II) by The Tamilnadu Dr.M.G.R. Medical University, Chennai.

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# DECLARATION

I declare that the dissertation entitled **"OUTCOME ANALYSIS OF CROSS PINNING VERSUS LATERAL PINNING IN SUPRACONDYLAR FRACTURES OF HUMERUS IN CHILDREN"** submitted by me for the degree of M.S is the record work carried out by me during the period of May 2012 to August 2013 under the guidance of **Prof.V.SINGARAVADIVELU,** M.S.ortho., D.Ortho., Professor of Orthopaedics, Institute of Orthopaedics and Traumatology, Madras Medical College, Chennai. This dissertation is submitted to the Tamilnadu Dr.M.G.R. Medical University, Chennai, in partial fulfillment of the University regulations for the award of degree of M.S.ORTHOPAEDICS (BRANCH-II) examination to be held in April 2014.

Place: Chennai Signature of the Candidate

Date: **(Dr. R.SENTHIL KUMAR)**

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# CONTENTS

# ABSTRACT OF THESIS

**DONE BY R. SENTHIL KUMAR**

**INTRODUCTION:**

Displaced supracondylar fracture of humerus in children is commonly treated by closed or open reduction and reduction held by kirschner wires. Biomechanically cross pinning is superior than lateral pinning but there is a risk of ulnar nerve injury. Recent studies suggest lateral pinning if properly done has equal stability and there is no risk of ulnar nerve injury.

**AIM OF STUDY:**

To compare the cosmetic and functional outcome of displaced supracondylar fracture humerus in children treated with cross pinning and lateral pinning.

**MATERIALS & METHODS:**

**Inclusion Criteria:**

Type II, Type III gartland fractures

Fractures treated by closed or open reduction

Age less than 15 years

**Exclusion Criteria:**

Type I Gartland Fractures

Age more than 15 years.

In cross pinning precautions were taken to protect ulnar nerve in closed reduction. In lateral pinning 2 or 3 wires placed in divergent or parallel configuration. The cosmetic and functional outcomes were done by flynns criteria.

**RESULTS:**

All 9 cross pinning patients had satisfactory results. All 12 cross pinning patients had satisfactory results. There was a single case of ulnar nerve injury in cross pinning group and no such case in lateral pinning group.

**CONCLUSION:**

Cross pinning is the most stable configuration where as lateral pinning is equally stable configuration in maintaining the reduction of displaced supracondylar fractures of humerus in children. Cross pinning has a definitive risk of iatrogenic ulnar nerve injury where as there is no risk of ulnar nerve injury in lateral pinning.

# INTRODUCTION

# INTRODUCTION

Supracondylar Humerus Fracture is the commonest elbow fracture in children. Undisplaced fractures are treated conservatively with posterior splint . Displaced fractures are to be reduced by closed or open method and to be stabilized with Kirschner wires to avoid loss of reduction leading to malunion and cubitusvarus deformity..Kirschner wires can be applied in various configurations to stabilize the reduced fracture. One of the configuration is insertion of one pin medially and one pin laterally through the corresponding epicondyles. Although this configuration is biomechanically superior, there is a risk of iatrogenic ulnar nerve injury during insertion of medial pin.Most of these nerve injuries recover completely over two to three months duration.Rarely it may lead to permanent deficit leading to functional disabilities.To overcome this complication, two or three kirshnerwires were inserted through lateral epicondyle. But lateral pin fixation is biomechanically less stable as rotation at fracture site may occur. It has been argued that lateral pinning if done by proper technique provides almost equal stability similar to cross pinning without any risk of iatrogenic ulnar nerve injury.

# AIM OF THE STUDY

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To compare the cosmetic and functional outcome of displaced supracondylar fractures of the humerus in children treated with cross pinning and lateral pinning .

# REVIEW

# OF

# LITERATURE

# REVIEW OF LITERATURE

Supracondylar humerus fracture is the commonest elbow fracture in children. The displaced supracondylar humerus fracture known for its complications of malunion, Volksmann'sischaemic contracture etc.

Astley Cooper [5](1826), Robert Jones [5](1921),Watson Jones [5] (1952-5), charnley (1961) treated with cuff and collar with elbow in flexion for a minimally displaced fracture.

Various methods of skin traction and skeletal traction were used as treatment methods to maintain reduction which are of historic interest only. Treatment for a displaced fracture with severe swellingwas adviced by Blount et al[5] 1951 by closed reduction aided by posterior periosteum and triceps. Secondary displacement occurred in plaster and cubitusvarus occurred - DAmbroisa[5] (1972). The problem of Mc Laughlin " Supracondylar Dilemma"[5] was identified. That is the fracture gets reduced by flexion of elbow but the vascularity gets affected by flexion needing extension of elbow resulting in loss of reduction - Rang [5] (1974)

Charnley[5] in 1961 pointed out that flexion of swollen elbow increased pressure in cubital fossa compromising vascularity and on

extension pressure decreases suggested to avoid hyperflexion particularly in existing neurovascular injury.

Open reduction and internal fixation was done by Ramsey and Griz[5] (1973), Shifrin[5] (1976), weiland et al[7] (1978) .The complication of postoperative stiffnesswas high .

Blind pinning was done by Flynn et al[8] (1974) to maintain reduction and avoid postoperative stiffness by open reduction and decrease the vascular complications. But the occurrence of ulnar nerve injury was high.

Threaded kirschner wires were used initially but damage to soft tissues including ulnar nerve was more. Removal of threaded wire was difficult. Smooth kirschner wires were used to minimize soft tissue damage and to facilitate easy removal.

With the availability of the intra-operative imaging systems attempts were made to reduce the fracture by closed methods and to stabilize the fracture by percutaneous pinning.

The complication of ulnar nerve injury following medial pinning was avoided by Arino et al[6] bydoing lateral pinning alone . In lateral pinning complication of ulnar nerve injury did not occur

Various configurations of Kirschner wires were evaluvated for stabilizing the reduction. Various bio mechanical studies were done in animal and human cadaveric models to determine the appropriate pin size, number, configuration to equalize the stability of cross pinning.

Zionts et al[9] in his study found the two cross pins placed from medial, lateral epicondyles provided maximum stability. The torque require to produce 10 degree of rotation was 37% less with the use of 2 parallel pins, and 80% less with two lateral cross pins.($p<0.05$ for both). The torque required to produce 10 degree of rotation with the use of three lateral pins was 25% than with the use of medial and lateral crossed pins.

Reza Omid [10] (JBJS Am 2008; 90:1121-32) et al in their study has recommended lateral pinning is the current modality of treatment which when placed properly provides stability with out iatrogenic ulnar nerve injury.

David L Saggs et al[14] (JBJS vol 86-A No 4 April 2004) has concluded the use of lateral pins alone was effective for the most unstable supracondylar humerus fractures without loss of reduction and iatrogenic ulnar nerve injury if the pins engaged both cortex, and both fragments maximally separated at fracture site.

The incidence of ulnar nerve injury during medial pin fixation varied between 0 % to 15%. Mark Eidelman[15] (2007) et al described flexion-extension cross pinning to prevent iatrogenic ulnar injuryduring medial pinning of supracondylar fracture humerus in children.

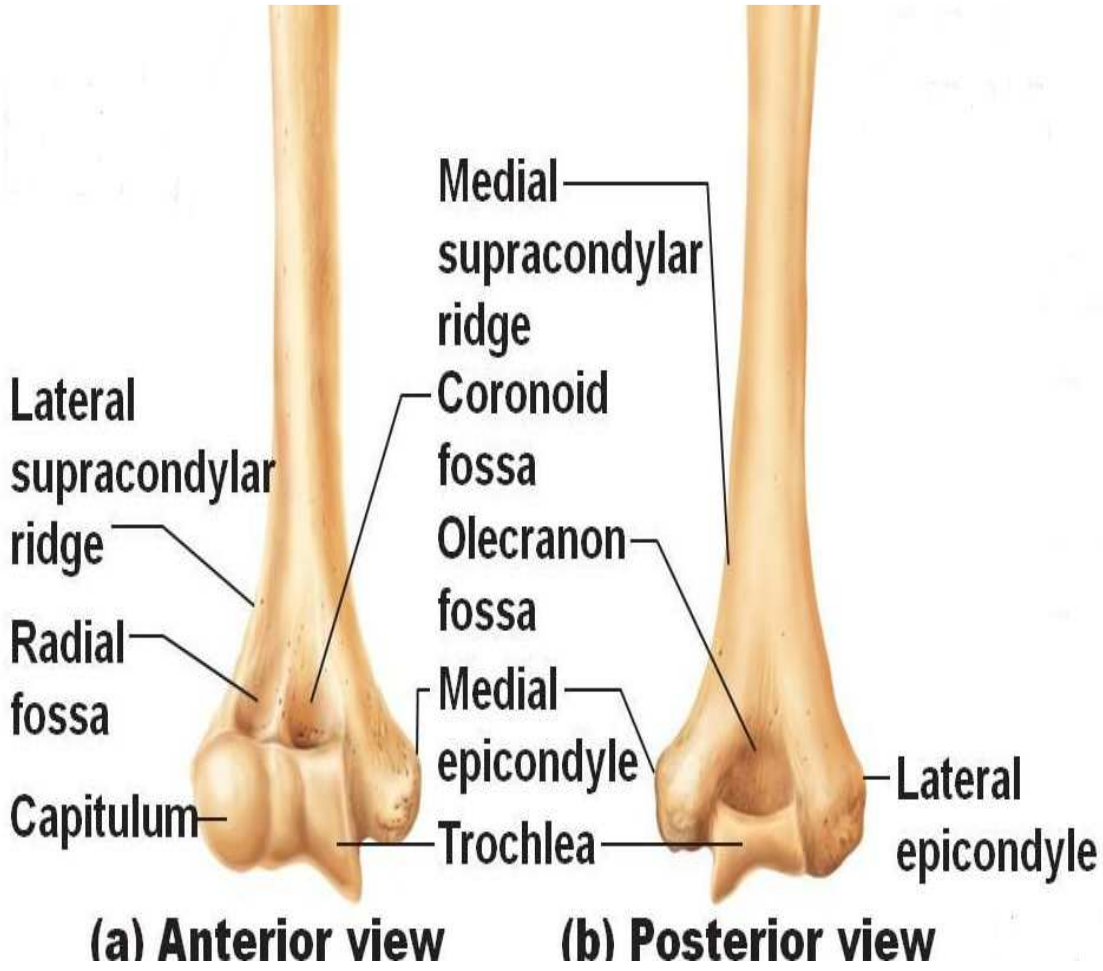
The decision regarding with the management of pulseless supracondylar humerus fracture in children has outlined by Amanda wWeller et al[18] (JBJS Am2013;95:1906-12).There is no indication to explore even if pulse is not felt after closed reduction can be observed as long as there is doppler signal and distal perfusion.

# APPLIED ANATOMY

# APPLIED ANATOMY

## ANATOMY OF LOWER END OF HUMERUS

The lower end of humerus is wider transversely. It has articular and non-articular parts. The lower end is divided into medial and lateral part. The lateral convex part is capitellum articulates with the radius. The medial pulley shaped trochlea articulates with ulna. The non articular parts include medial and lateral epicondyles.



## CAPITELLUM

Less than half of a sphere, capitellum forms anterior and inferior surface of lower end of humerus laterally. It articulates with radial head which in extension abuts on the inferior surface and in flexion slides onto anterior surface.

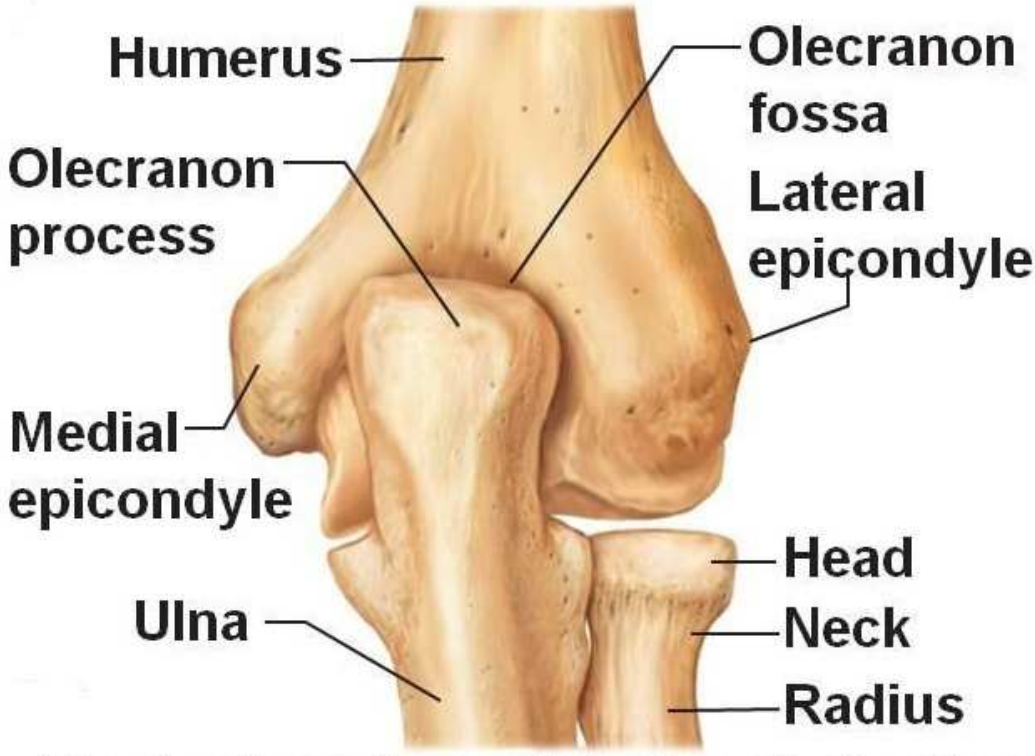
## TROCHLEA

It is a pulley like structure forming anterior, inferior, posterior surface of lower end of humerus medially. It is separated laterally from capitellum by a faint groove; all aspects of its medial margin project. It articulates with the trochlear notch of the ulna. In extension the inferoposterior trochlear circumference contacts the ulna but in flexion the trochlear notch slides onto the anterior aspect, the posterior being uncovered. The projecting medial trochlear edge is a main determinant of the angulation between the long axis of humerus and ulna when the forearm is extended and supinated. The articular surface of trochlea and capitellum projects distally and anteriorly at an angle of 30-45 degrees.

**THE MEDIAL EPICONDYLE**

It is a blunt medial projection of medial condyle. It is subcutaneous. It is visible in passive flexion. Its posterior smooth surface is crossed by ulnar nerve in a shallow sulcus as it enters the forearm. The ulna nerve can be rolled against the bone. To the anterior epicondylar surface forearm flexors are attached. The medial humeral border ends at medial epicondyle and is distally the medial supracondylar ridge. The common superficial flexor tendon arises from the medial epicondylar epiphysis which is wholly extracapsular. The medial condyle turns slightly backwards.


**Anterior View at the elbow region**




**Posterior view of extended elbow**

## LATERAL EPICONDYLE

It is the lateral non articular part of lateral condyle. It has an antero lateral impression for superficial forearm extensors. Its posterior surface is slightly convex and is easily felt in a depression visible behind the extended elbow. The lateral humeral border ends at lateral epicondyle from which extending proximally is its distal part, the lateral supracondylar ridge. The common superficial extensor tendon is attached to the lateral epicondyle outside the articular capsule. The lateral epicondyle turns slightly forward.

## OLECRANON FOSSA

It is a deep hollow on the condyle's posterior surface proximal to trochlea contains the apex of olecranon in the extended elbow. Its floor is always thin and may be deficient.

## CORONOID FOSSA

It is a smaller fossa immediately proximal to the trochlea on the anterior surface accommodates the margin of ulnar coronoid process in full flexion.

## RADIAL FOSSA

It is a shallow fossa proximal to capitellum and lateral to coronoid fossa is related to margin of radial head in full flexion

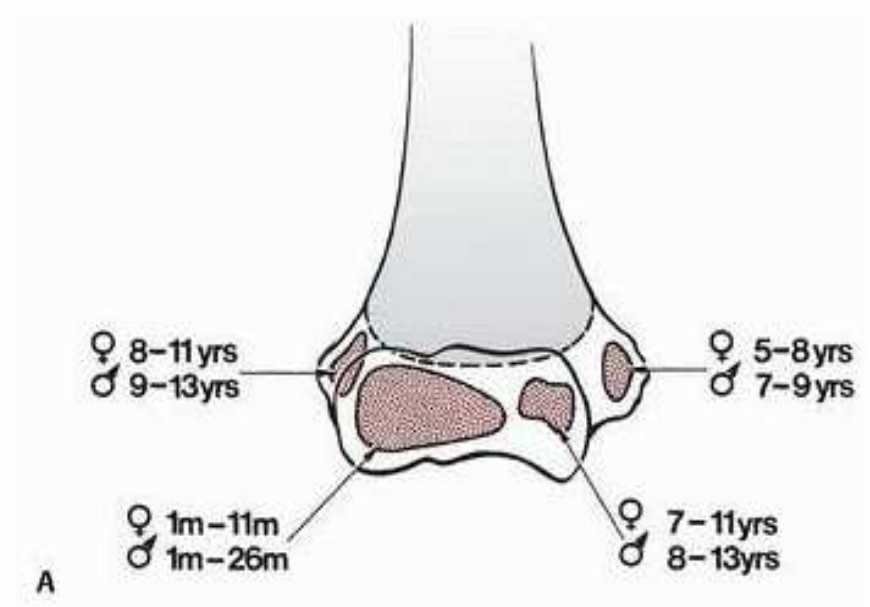
## APPEARANCE OF OSSIFICATION CENTRES OF THE BONES AROUND ELBOW JOINT

Table showing appearance of ossification centers in girls and boys

| | Girls (y) | Boys (y) |
|---|---|---|
| Capitellum | 1.0 | 1.0 |
| Radial head | 5.0 | 6.0 |
| Medial epicondyle | 5.0 | 7.5 |
| Olecranon | 8.7 | 10.5 |
| Trochlea | 9.0 | 10.7 |
| Lateral epicondyle | 10.0 | 12.0 |

The ossification centre appears earlier in girls than in boys

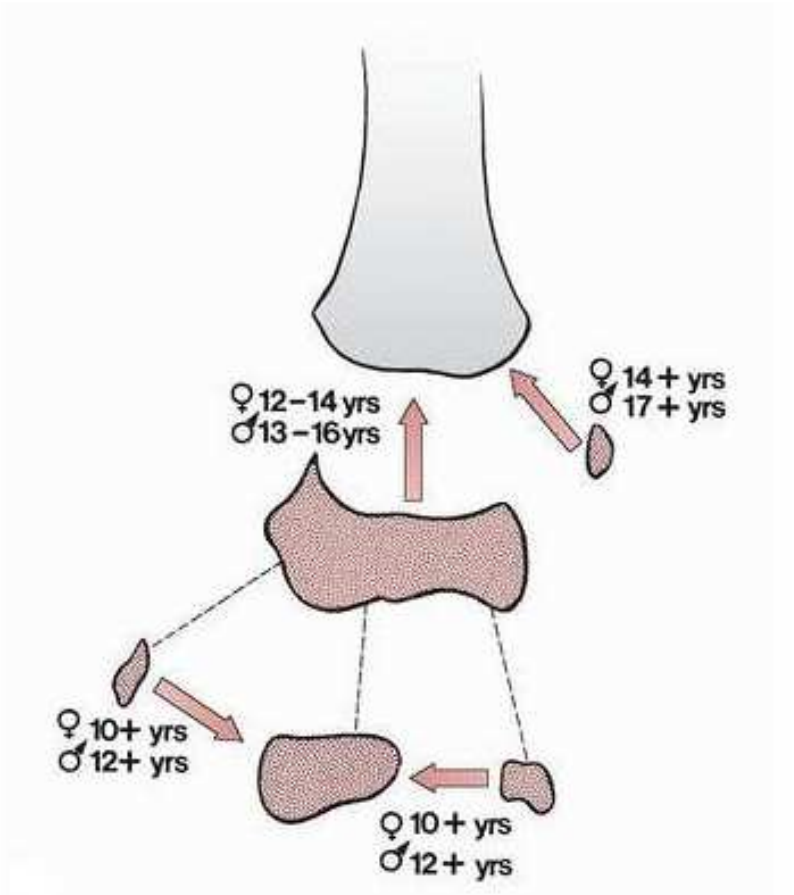
### Ossification centers of distal humerus



## FUSION OF OSSIFICATION CENTRES OF THE BONES AROUND ELBOW JOINT

The epiphyseal ossification centers present in the distal humerus fusetogether and then fuse with metaphysis. Theossification center that fuses last with metaphysis is medial epicondyle. The proximal radial and olecranon epiphyseal centresfuse with their respective metaphysis occurs at the same time as the distal humerus, between 14-16 years of age.

Diagram showing fusion of ossification center of distal humerus

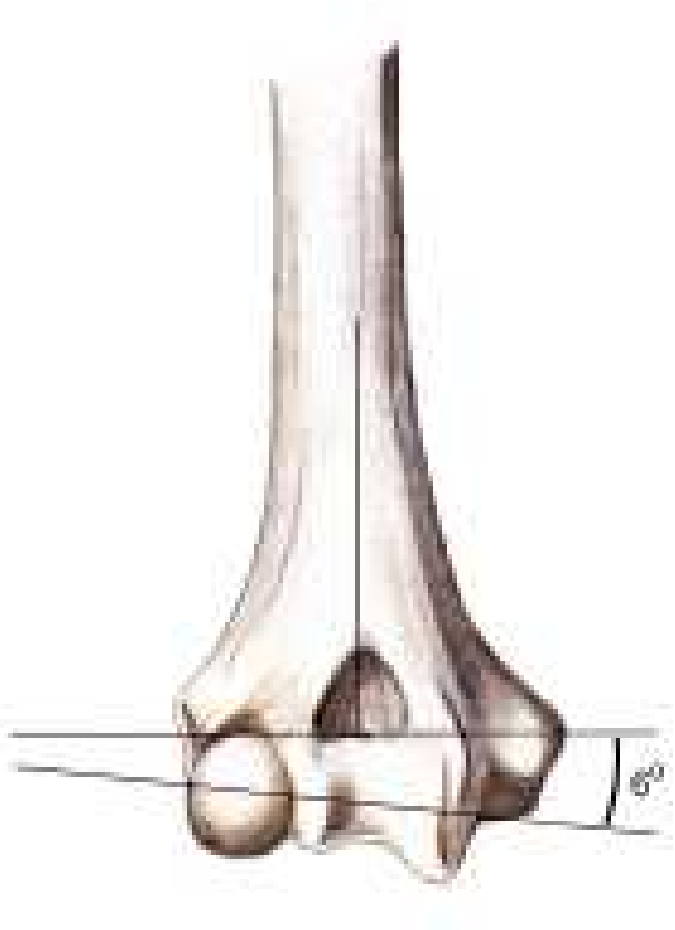


## CARRYING ANGLE

The spiral orientation of the trochlea in humeroulnar joint, has resulted in an angular valgus alignment of the forearm with the humerus. The angle formed is termed as the carrying angle. So the transverse axis of the elbow is not perpendicular to the long axis of the humerus or even the forearm. But is slight oblique to both. This obliquity of the axis of the elbow causes the long axes of the humerus and forearm to be parallel when they are superimposed in full flexion.

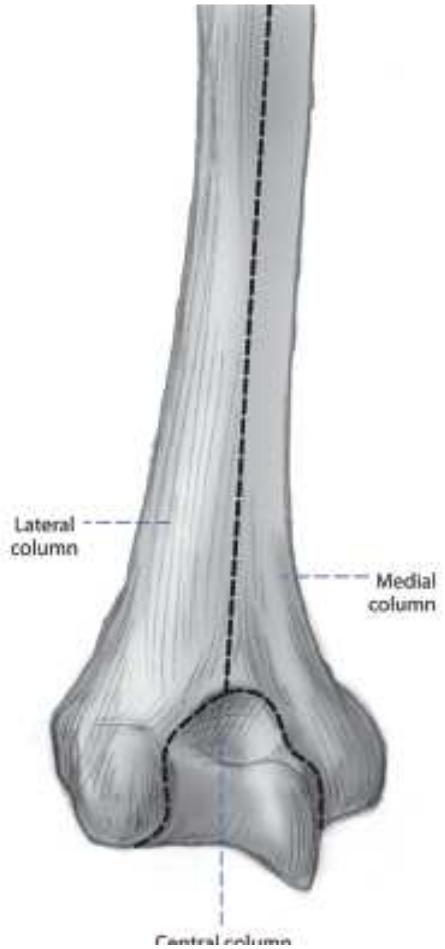
The carrying angle changes with flexion. Thus the flexion contractures make radiographic estimation of carrying angle meaningless.

The carrying angle of the elbow joint in children is not constant. The carrying angle in boys averaged 5.4 degrees and rangedfrom 0 to 11 degrees whereas in girls it averaged 6 degrees and ranged from 0 to 12 degrees. The clinical method of assessing the carrying angle is by measuring the angles subtended by lines drawn from the midpoint of wrist to midpoint of antecubital space and midpoint of head to antecubital space with arm externally rotated, elbows fully extended with forearms supinated.



**THREE COLUMN CONCEPT**

The lower end of the distal humerus is divided into 3 columns[11] namely lateral, medial and central columns. The stabilization of 2 columns is a must to maintain the reduction. In cross pinning both medial and lateral columns has to be fixed. In Lateral pinning both lateral and central columns has to be fixed.




**THREE COLUMNS**

# SUPRACONDYLAR FRACTURE OF HUMERUS IN CHILDREN

# SUPRACONDYLAR FRACTURE HUMERUS

It is the commonest fracture of elbow in children. Between 5 to 6 years of age, the incidence of occurrence of fracture is maximum. It is more common in male children than in female children. The non-dominant or left side is commonly involved than the right side. Extension type (97%) of injury is more common than flexion-type injuries.

## MECHANISM OF INJURY

Supracondylar fracture is caused by fall on outstretched hand with elbow extended. The thin segment of bone connecting the medial and lateral columns of lower end of humerus between coronoid fossa anteriorly and olecranon fossa posteriorly is susceptible to fracture.

In hyperextended elbow, the olecranon occupies the olecranon fossa. The olecranon acts as fulcrum. The anterior capsule provides tensile force on the lower end of the humerus proximal to its insertion. As the bending force progresses the lower end of the humerus fractures anteriorly in the thin segment. The proximal fragment displaces anteriorly impinging on soft tissue structures brachialis muscle, brachial artery, median nerve. The distal fragment gets displaced posteriorly due to pull of triceps muscle.

## ROLE OF PERIOSTEUM

In extension type injuries the anterior periosteumis ruptured. The posterior periosteum is intact. The posterior periosteal hinge provides stability and it maintains reduction after reduction of fracture is achieved by flexing the elbow to 90 degree and pushing the distal fragment forward with forearm pronated.

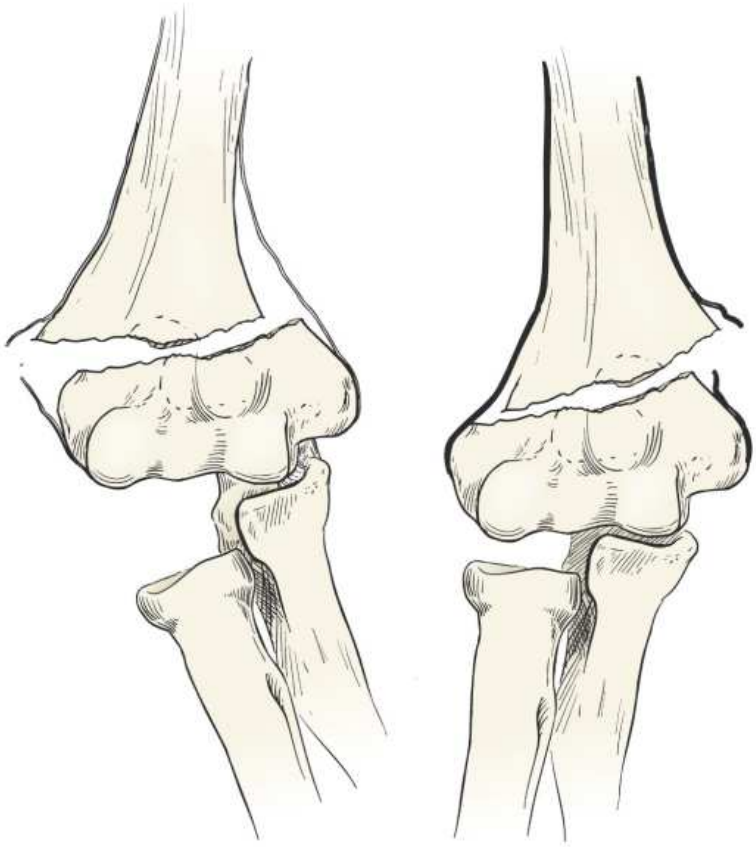
The intactness of medial or lateral periosteum can be determined by direction of displacement of distal fragment. If the medial periosteum is intact, the distal fragment is displaced posteromedially. If the lateral periosteum is intact the distal fragment is displacedposterolaterally.

In posteriomedial displacement, by placing tension on intact medial periosteum pronation closes the hinge and malalignment is corrected. In posterolateral displacement supination corrects the malalignment.

If the anterior and posterior periosteumare torn, the fracture is unstable in both flexion and extension.

In flexion type supracondylar fractures the posterior periosteum is torn and unstable in flexion.

## POSTEROMEDIAL VERSUS POSTEROLATERAL DISPLACEMENT OF EXTENSION TYPE SUPRACONDYLAR FRACTURES

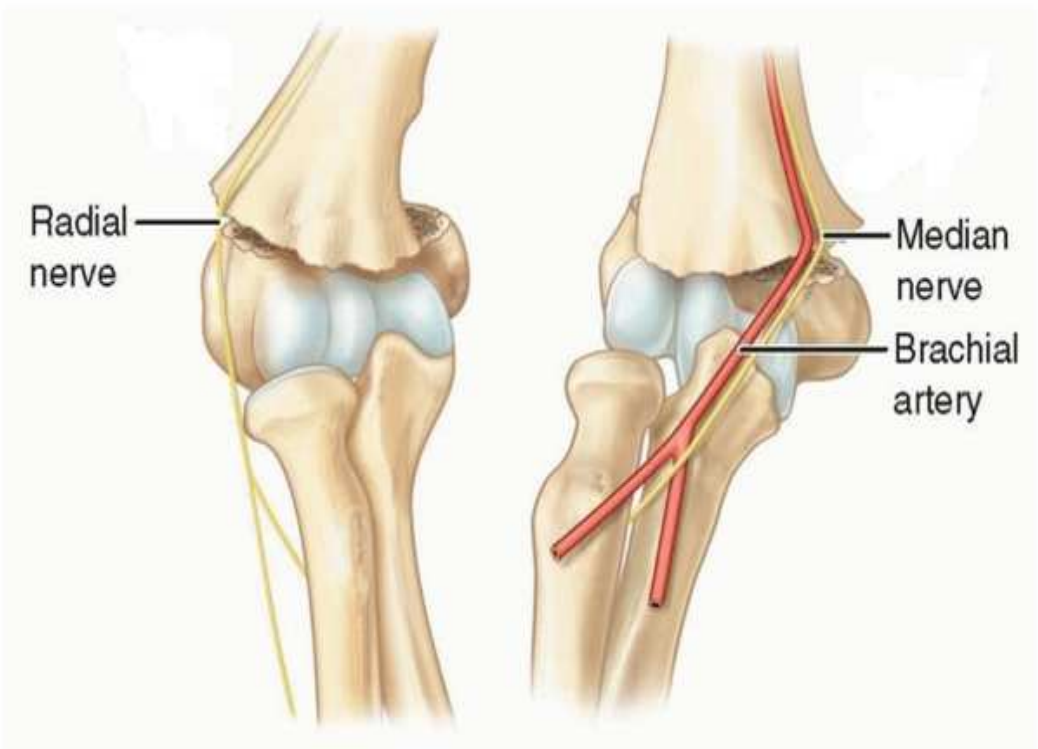


**Posteromedial and Posterolateral Displacement**

Posteromedial displacement is common than lateral displacement. The direction of displacement determines the soft tissues at risk by the proximal metaphyseal fragment.

In posteromedial displacement of the distal fragment, the metaphyseal spike of the proximal fragment pierces laterally and the radial nerve is at riskof injury.

In posterolateral displacement of the distal fragment, the metaphyseal spike of the proximal fragment pierces medially and the median nerve and the brachial artery are at risk of injury.



## CLASSIFICATION

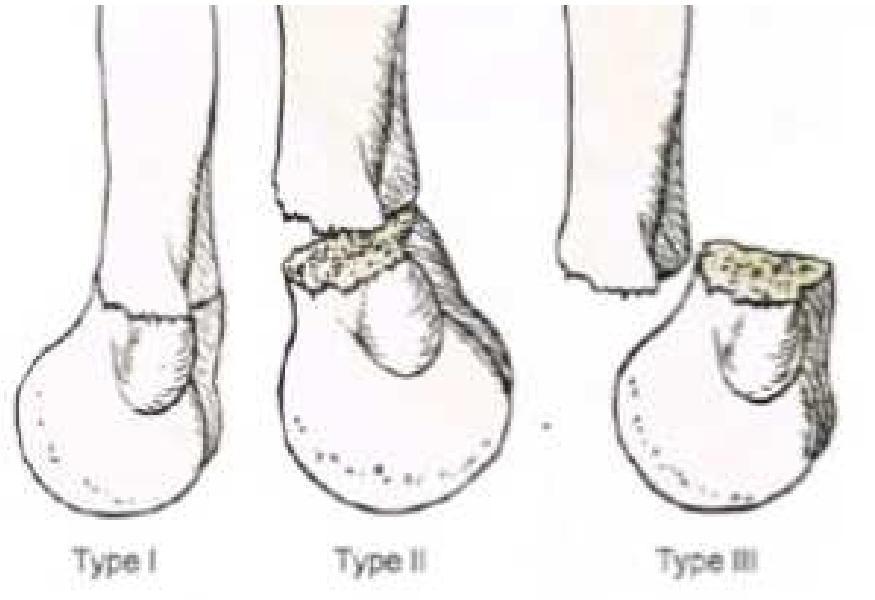
The most commonly used classification in Supracondylarhumerus fractures in children is Modified Gartland classification.

Type 1 : undisplaced or displaced by less than 2 mm. Anterior humeral line is intact. Osseous injury may or may not be seen in xray. Posterior fat pad sign may be the only radiological evidence. The periosteum is intact all around and it is the most stable type

Type 2 : Displaced by more than 2 mm. The posterior cortex is hinged. The anterior humeral line will not go through middle third of capitellum. No rotational deformity will be seen in anteroposterior radiograph. Posterior periosteum is intact.

Type 3: There is no cortical contact. the distal fragment is in extension in sagittal plane and rotated in transverse plane. The periosteum is torn. Soft tissue and neruo vascular injury is more common. Medial column comminution may be present.

| TYPE | DISPLACEMENT |
|---|---|
| Type 1 | Undisplaced |
| Type 2 | Hinged posteriorly |
| Type 3 | Displaced |



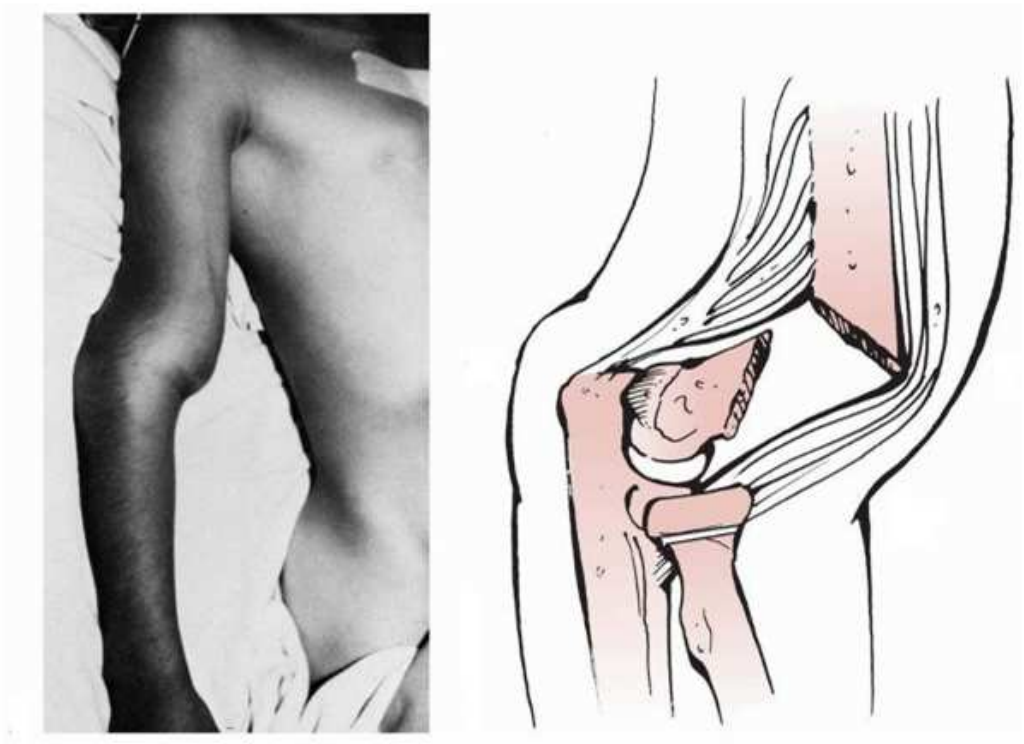

Leitch et al[10] described type 4 supracondylar humerus fracture in children The fracture is unstable in both flexion and extension. The multidirectional instability is usually detected under anaesthesia. The instability may have occurred during the initial trauma or iatrogenically with repeated reduction attempts

## CLINICAL EVALUATION

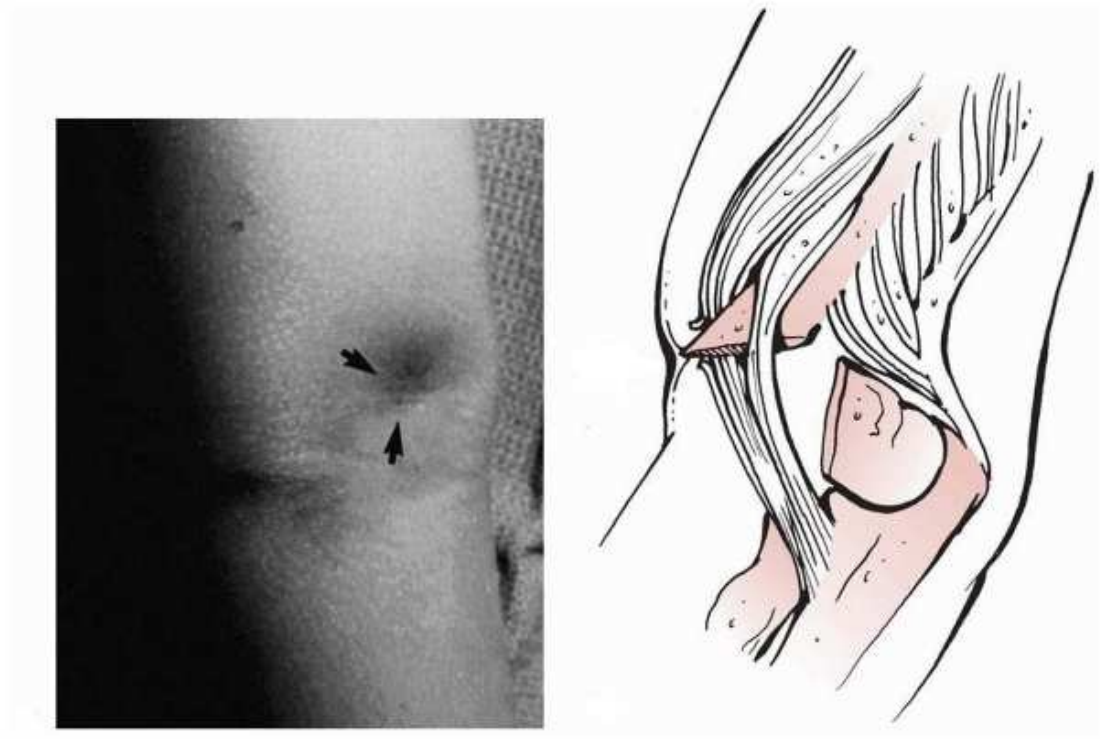
Supracondylar humerus fractures in children is suspected in the child with complaints of pain elbow or inability to use the upper extremity following history of fall onto outstretched hand with elbow extended.

There may be swelling of elbow, deformity, tenderness on both medial and lateral column of the distal end of humerus, restriction of range of movements with or without distal neurovascular injury.

In type 1 supracondylar humerus fracture, there will be tenderness and loss of motion. In type 3 supracondylar humerusfracture, there will be obvious s-shaped deformity due to prominence of the distal part of the proximal fragment and extension of the distal fragment.



The anterior pucker sign will be present if the proximal fragment pierces brachialis muscle and anterior fascia of the elbow involving deep dermis. The fracture is considered open if any bleeding is noted at the puckered site at presentation or after reduction of the fracture.



Motor evaluation includes radial nerve, anterior interosseous nerve, median nerve, ulnar nerve. For radial nerve, wrist extension, finger extension, thumb extension is examined. For anterior interosseous nerve, index finger distal interphalangeal joint flexion and thumb interphalangeal joint flexion is examined. For median nerve, thenar strength is examined. For ulnar nerve, interossei muscle is examined.

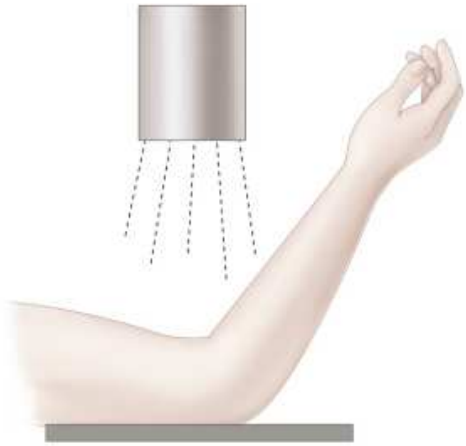
Sensory evaluation includes radial nerve, median nerve, ulnar nerve. The autonomous sensory areas of nerves are examined. For radial nerve, dorsal first web space is examined. For ulnar nerve palmar little finger is examined. For median nerve, palmar index finger is examined.

Vascular evaluation is done by checking the distal pulses, warmth, capillary refill and colour.

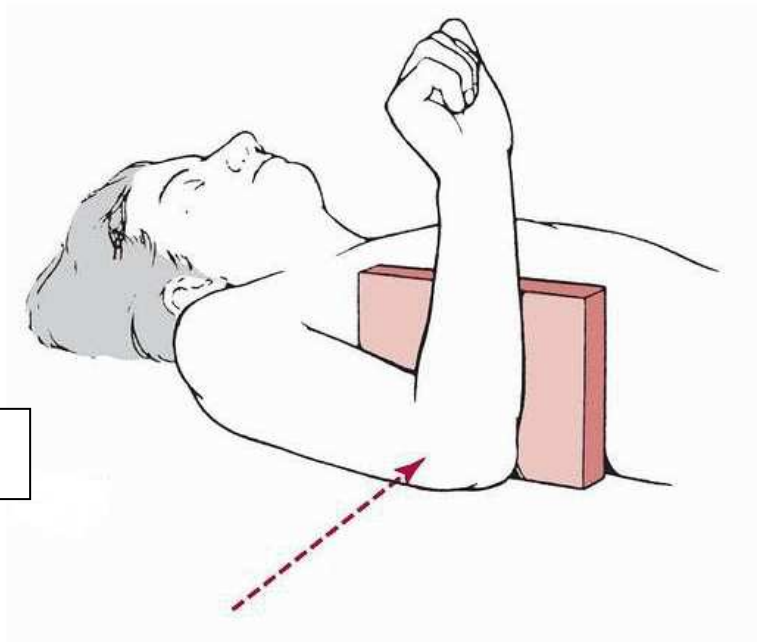
The presence of compartment syndrome is suspected when there is tense swelling of the forearm associated with classic 5 P's - Pain, Pallor, absence of Pulse, Paresthesias and Paralysis. Associated fractures of forearm increases the risk for compartment syndrome.

Radiographic evaluation includes anteroposterior and lateral views of the whole extremity to rule out associated fractures. True Anteroposterior view of lower end of humerus is taken rather than anteroposterior view of elbow. The true lateral view of elbow is taken with humerus in neutral position and not in external rotation.

AP View of distal humerus



Lateral View of elbow

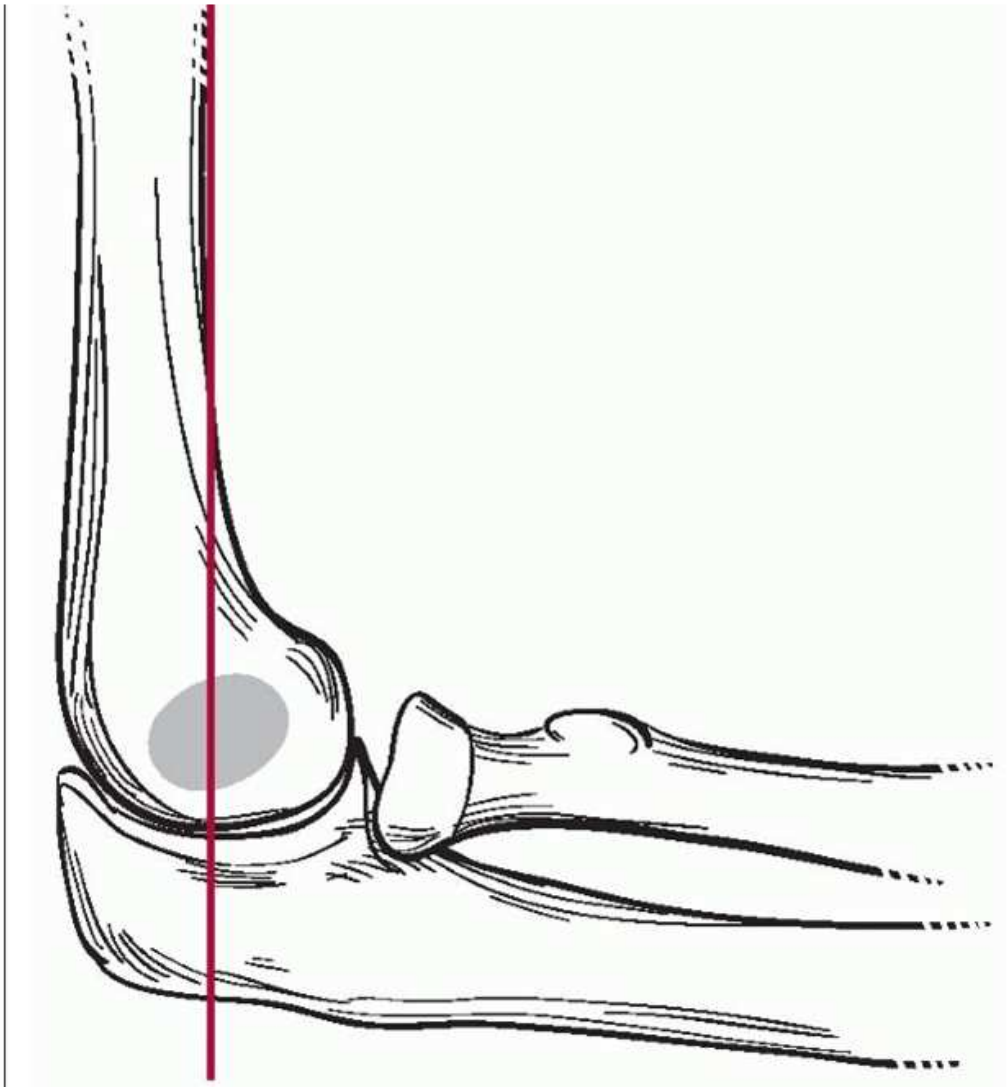


Comparison views of contralateral side may be needed in evaluating the physis. Oblique view of lower end of humerus may be needed if fracture is not seen in routine views.

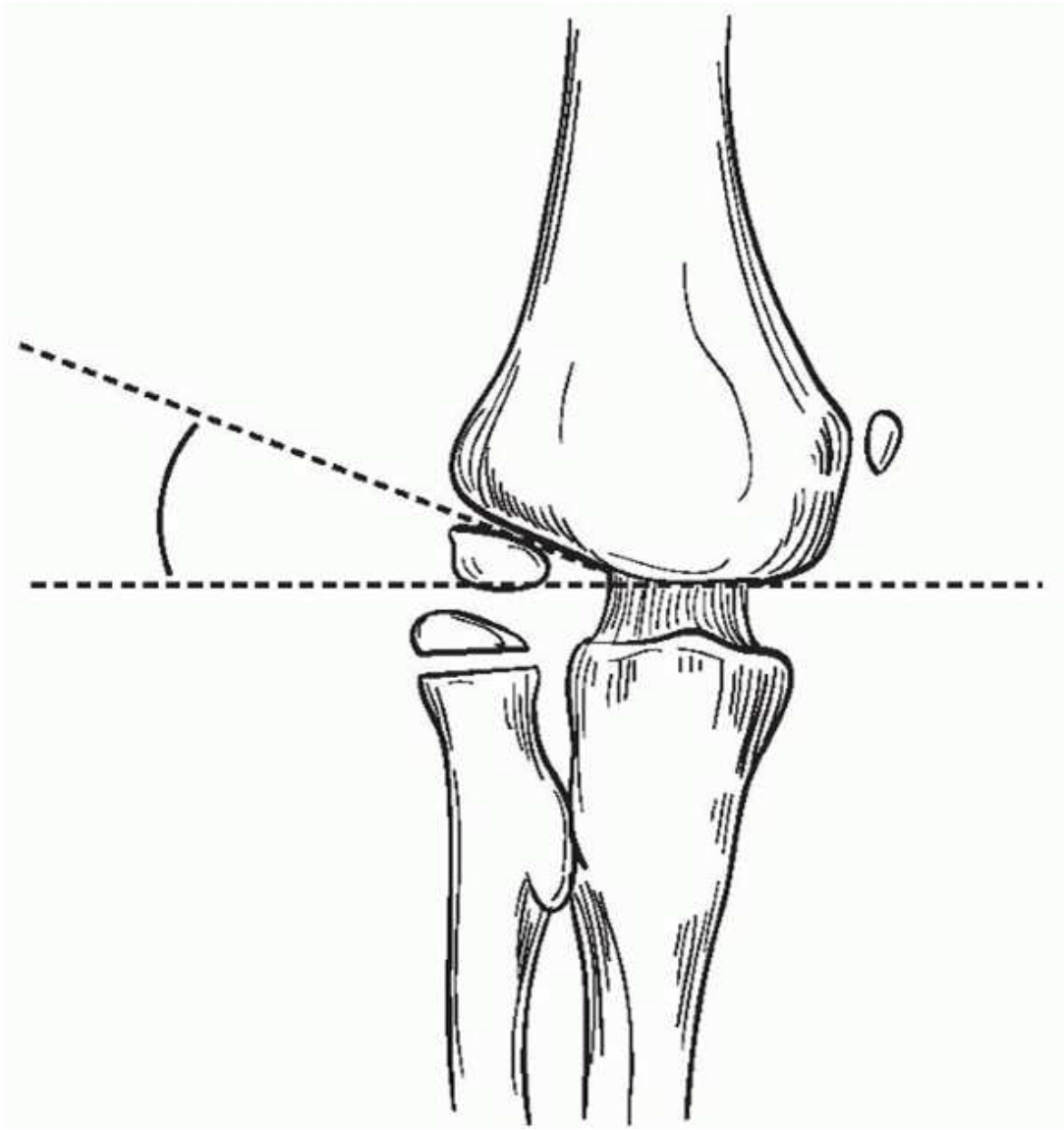
The radiographs may be negative. It may show the posterior fat pad sign. The displacement of fracture fragments becomes obvious with increasing types of supracondylar humerus fracture. The medial column impaction, supracondylar comminution, vertical split of the distal fragment were evaluated.

Anterior humeral line and Baumann's angle (humeral capitellar angle) are used to diagnose the presence of supracondylar humerus fracture.

Anterior humeral line is a line along the anterior border of distal humerus shaft passes through middle third of ossification centre of capitellum.in a true lateral view of elbow. The line is posterior in extension type fractures. Passage of anterior humeral line through the anterior portion of the lateral condylar ossification centre or anterior to it indicates the posterior angulation of the distal fragment in post reduction radiograph.

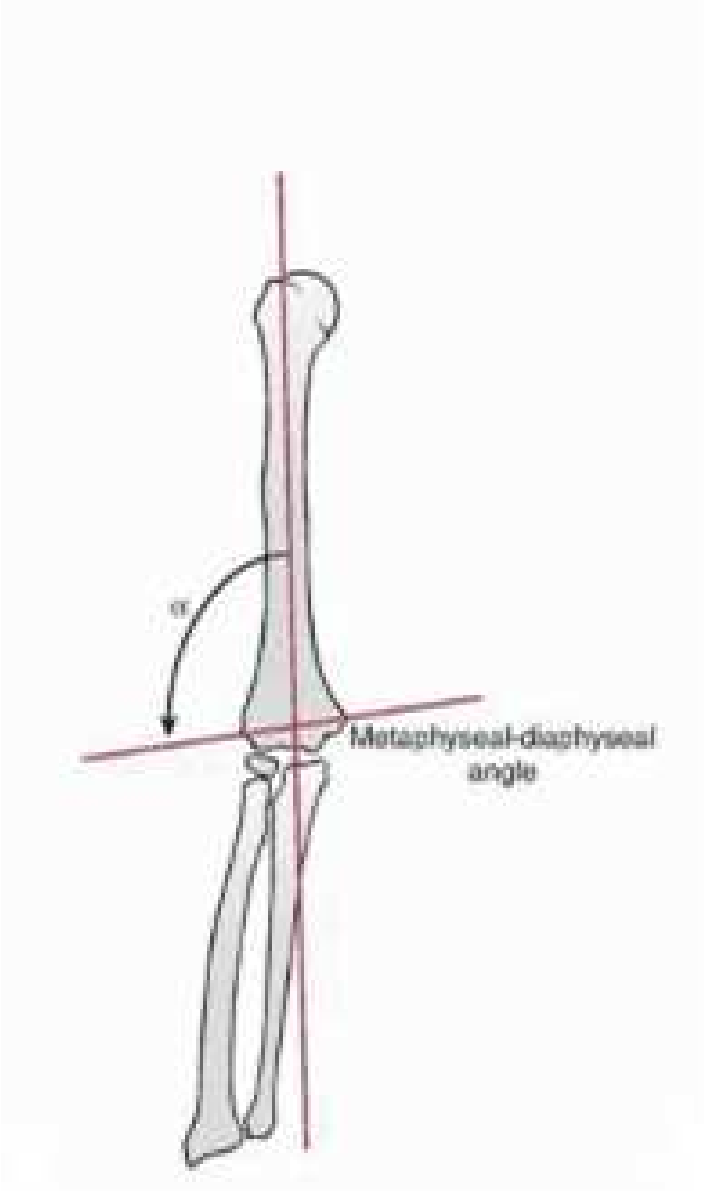


Baumann’s angle is the angle between the line drawn perpendicular to the long axis of humeral shaft and the physeal line of the lateral condyle. The normal angle ranges from 9 to 26 degrees. If the tube is angulated in Cephalad or Caudal direction, the angle is changed significantly to make measurements inaccurate. Any decrease in Baumann’s angle below 10 degrees indicates the fracture is in varusmalallignment.

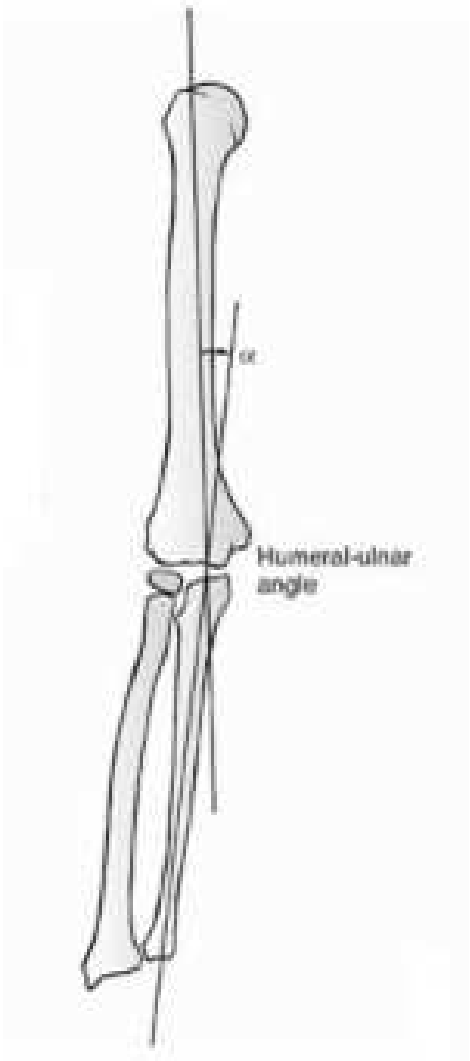


Crescent sign – Normally in a true lateral view of the elbow, the ossification centre of the lateral condyle does not superimpose on olecranon. There is usually a definite radiolucent space between two ossification centres. If there is a significant tilt of distal fragment then theses areas of ossification may overlap creating crescent sign

A transverse line is drawn through the metaphysis at the widest point and a longitudinal line is drawn through the axis of the diaphysis. Angle is measured between the lateral portion of the metaphyseal line and proximal portion of the diaphyseal line. Normal angle is 90 degree. If it increases more than 90 degree indicates varus angulation and any thing less than 90 degree valgus angulation.



Humeroulnar angle is determined by lines longitudinally bisecting the shaft of the humerus with the shaft of the ulna with the elbow fully extended and supinated. This angle is the most accurate in determining the true carrying angle of the elbow.



# TREATMENT

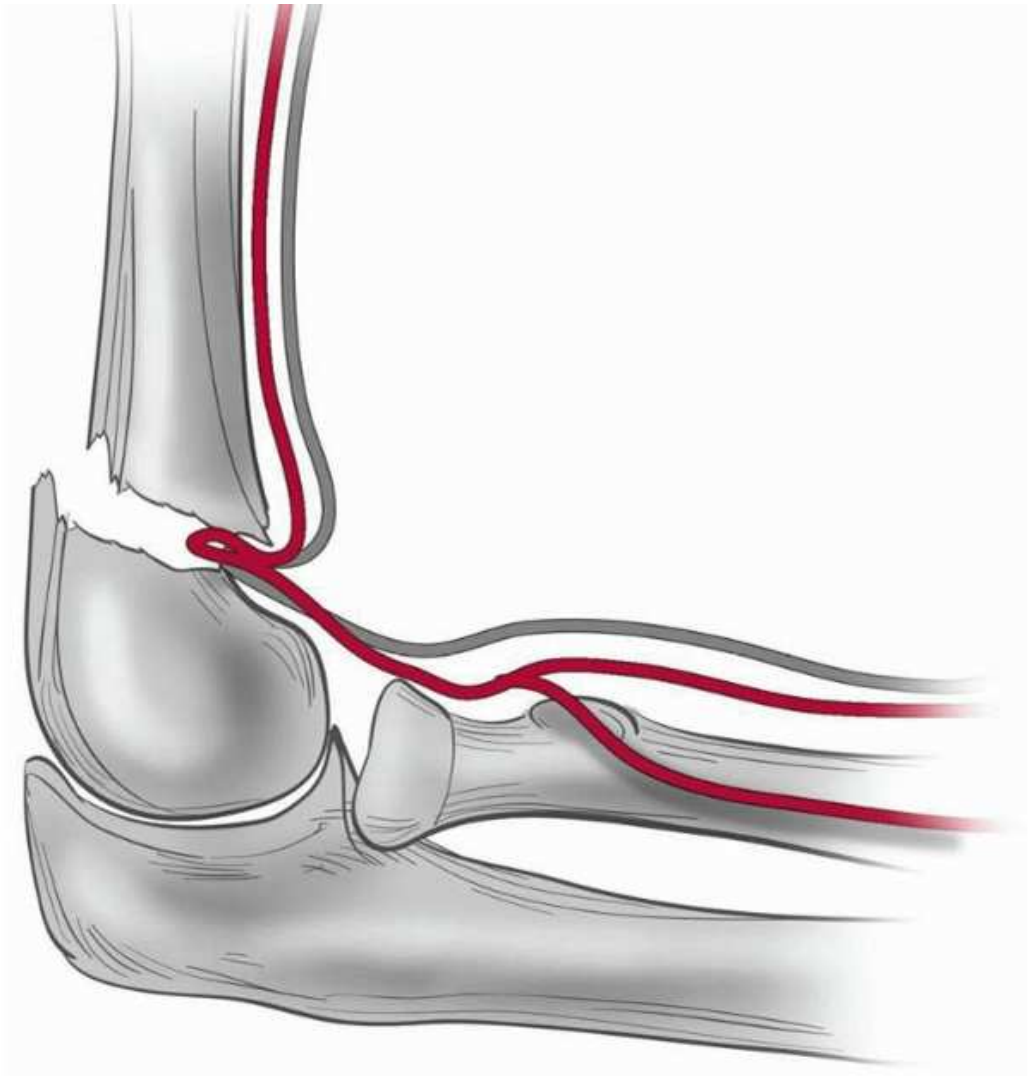
## INITIAL MANAGEMENT

All children with supracondylar humerus fracture are splinted in an above elbow slab in 20-40 degrees of elbow flexion to provide pain relief. Tight bandaging is avoided. Excessive flexion or extension is avoided as it may increase the compartment pressure and decrease the vascularity. The arm is elevated. Complete neurological and vascular examination done. Radiographs are then taken.

## CLOSED REDUCTION AND PIN FIXATION

Under general anaesthesia supine position the fracture is reduced in tranverse plane by applying traction and medio lateral plane. The elbow is flexed and olecranon is pushed anteriorly to correct saggital deformity. The following are the criteria for satisfactory reduction. In anteroposterior radiograph bawmanns angle should be greater than 10 degree. In oblique radiograph both medial and lateral column should be intact. In lateral view anterior humeral line should pass through middle third of capitellum. In case of cross pinning lateral wire is inserted first followed by medial pin after taking precaution to avoid ulnar nerve injury. In case of lateral pinning two wires in divergent or parallel configuration applied and checked for rotational stability. If found unstable a third pin. The elbow is

stabilized in 60 to 90 degree of flexion depending on vascular status. If any gap is noted in the fracture site or fracture is irreducible with rubbery feeling then median nerve are brachial artery may be entrapped in the fracture site needing open reduction.



## OPEN REDUCTION

Open reduction is done in case of failed closed reduction, compound fracture, vascular injury. Open reduction can be done by medial approach, lateral approach, anterior approach or posterior approach. Open reduction may be associated with stiffness of elbow, myositis ossificans, surgical scar and iatrogenic neuro vascular injury. Anterior approach is preferred in neurovascular injury as both fracture reduction and entrapped neuro vascular structure will be released. Posterior approached is not recommended because of the risk of elbow stiffness and risk of avascular necroris of trochlea due to disruption of posterior blood supply to it.

## TREATMENT BY FRACTURE TYPE

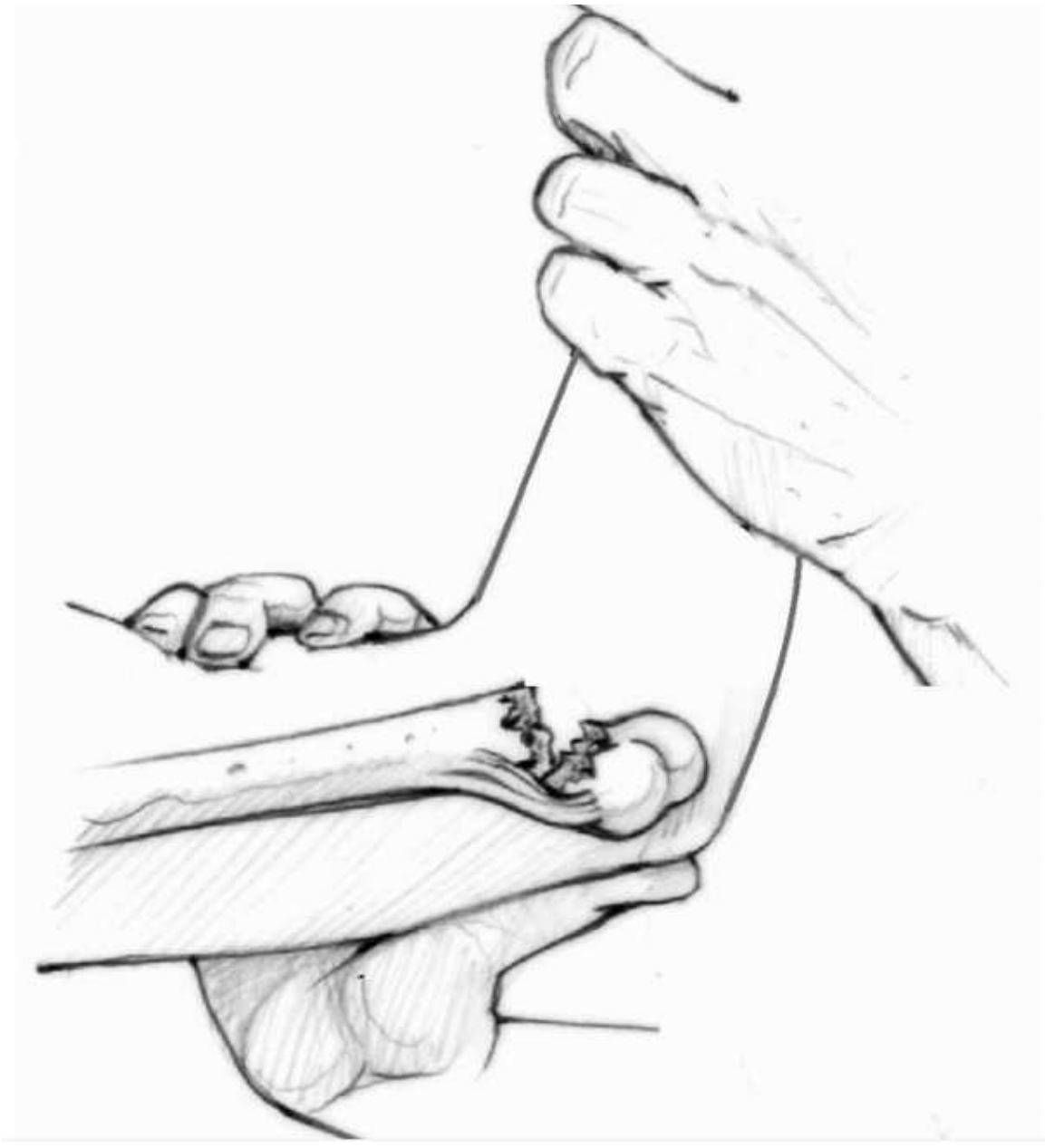
Type 1 supracondylar humerus fracture has a fracture line across both medial and lateral columns without displacement at the level of olecraneon fossa. The anterior humeral line passes through middle third of capitellum. The periosteum is intact and the fracture is stable. Radiography findings may be limited to a posterior fat pad sign. The elbow is immobilized with posterior splint at 60-90 degrees of flexion with side support and the forearm in neutral position. The elbow should not be flexed more than 90 degrees as it may compromise vascularity. X-

Rays are taken 3 to 7 days later to recheck the position. Periosteal reaction is noted in the follow up X-Rays. Any medial column collapse may lead to varus deformity. The fracture is immobilized for 3 to 4 weeks duration after which the plaster is removed, range of motion exercises started.

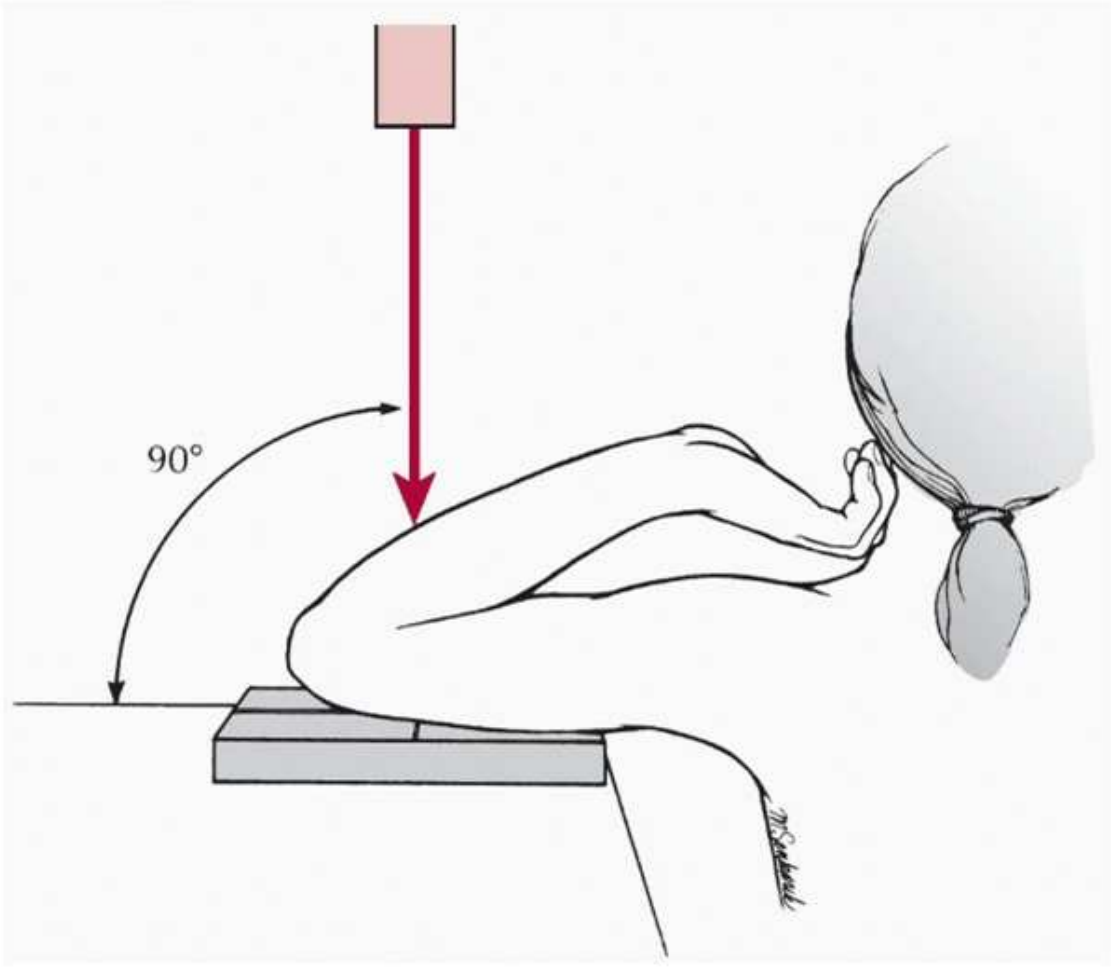
In type 2 supracondylar humerus fracture there is incomplete osseous separation. Some part of the posterior cortex is still in contact. The posterior cortex and periosteum provide inherent stability. With closed reduction stability can be obtained and can be maintained in posterior splint. Medial column collapse will lead to varus deformity. In such cases surgical management is necessary. Two lateral pins is sufficient for stability. Cross pinning is not needed. The pins are left outside the skin and supported in posterior splint for 3 to 4 weeks. They are then removed and range of motion exercises are started.

In type 3 supracondylar humerus fracture, there is no posterior cortical contact, periosteum torn, associated with varying degree of soft tissue injury. Proper pre-operative evaluation, emergent reduction and pinning is must to avoid complications. Closed reduction is done under anaesthesia. Longitudinal traction is applied. This dislodges the proximal fragment from any entrapment in soft tissues. This maneuver restores the length. If the proximal fragment does not disengage from soft tissue a

milking maneuver is done by pulling the soft tissue away from the proximal fragment restoring the length. Then medial or lateral translation is corrected. Rotation is corrected simultaneously. A flexion reduction method is performed. The olecranon and posterior condyles are pushed anteriorly with pressure by surgeon’s thumb.



The elbow is then hyperflexed and pronated to get stable reduction.The pulse obliterates in this position. Pulse reappears after extension of elbow following fracture stabilization. The distal humerus alignment is verified in anteroposterior and lateral views. Jones view is taken to assess both columns of the distal humerus.




It is difficult to interpret the reduction of columns so the anteroposterior view is taken by rotating the arm slightly, medially or laterally to view the corresponding columns. The arm is then rotated

externally to get lateral view of distal humerus.The lateral image is evaluated for fracture reduction, restoration of distal humerus contour and anterior humeral line. In all posteromedially displaced supracondylar fractures rotating the arm is possible with fracture reduced and held in hyperflexed and pronated position. If the fracture reduction is unstable instead of rotating the arm and losing the reduction the C-arm may be rotated. Pinning is done on the lateral side first. The kirschner wire position is confirmed by C-arm in both views. A small incision is made in the skin and the pin is advanced with the power drill. The pin should pass through the lateral portion of the ossified capitellum, physis, lateral column and engage the opposite cortex proximally. The second pin is placed medially. Pinning is done on the medial side after taking precautions to protect ulnar nerve. Insertion is made over the skin of medial epicondyle. The pin is placed more horizontal than lateral pin and it should engage the lateral cortex proximally. In case of lateral pinning both pins are inserted on the lateral side.In case if reduction/stabilization cannot be achieved by closed reduction, open reduction can be done. In patients where closed reduction cannot be obtained there is a possibility of entrapment of neurovascular structures and open reduction is always indicated. In our institute availability of C-arm determines the method of reduction-closed or opened.

# COMPLICATIONS

## VASCULAR INJURY

The vascular evaluation consists of presence of radial pulse, warmth, capillary refill and colour. About 10–20 % of displaced fractures have vascular compromise. The vascular status can be categorized into

1) Well - perfused (warm, red) radial pulse present.
2) Well – perfused radial pulse absent.
3) Poorly – perfused cold, blue, radial pulse absent.

Patients with well - perfused hand never require vascular repair or develop compartment syndrome. Fracture stabilization is sufficient. Patients with poor perfusion may require vascular repair or develop compartment syndrome. Therefore, absent radial pulse is not an emergency but absent radial pulse with poor perfusion is an emergency. In these patients splint is applied in 20-40 degrees of flexion as extremes of flexion or extension may compromise vascularity.

Fracture reduction restores distal pulse. If fracture reduction does not restore distal pulse and hand poorly perfused the artery may be incarcerated. The artery is freed by open reduction via anterior approach. The arterial spasm is relieved with lidocaine application or warming. After 10-15 minutes if pulse does not return and perfusion is poor

vascular reconstruction is contemplated.

When the elbow is flexed more than 120 degrees even when there is no vascular injury  the radial pulse is lost after pinning. Even when the elbow is extended the pulse does not return immediately. This is due to spasm of the artery,  about 10 to 15 minutes is allowed before taking any further decision. If the pulse does not return but well perfused hand,it is better to observe and treat accordingly.

Open reduction is indicated in child with radial pulse present pre-operatively but absent post operatively and artery is suspected to be entrapped in between the fracture site which is detected by a gap in fracture side or a rubbery feeling in irreducible fracture on reduction.

Post operative monitoring includes pulse oximetry, temperature of hand and development of compartment syndrome. The limb is placed in splint with elbow flexed less than 90 degree.

The vascular compromise should be treated within 12 hours. Any delay in treatment may lead to Volkmann ischemic contracture.

## COMPARTMENT SYNDROME

The risk of compartment syndrome is 0.1-0.3%. It may occur with or without brachial artery injury. Other causes include direct muscle injury, swelling due to associated forearm fracture raising compartment pressure, decreased arterial inflow, restricted venous outflow and position of elbow. The 5 P's for diagnosis are Pain, Pallor, absent Pulse, Paresthesias and Paralysis. Tight dressings if any should be loosened. Elbow is splinted in extended position below 90 degrees.Fracture should be stabilized. Forearm fasciotomy is indicated within 6 hours if the compartmental pressure is greater than 30 mm Hg to avoid ischaemic contracture.

## NEUROLOGICAL DEFICIT

The incidence of neurological deficit in children with supracondylar humerus fractures varies between 10 – 20%. Anterior interrosseous nerve is commonly injured. In posteromedial displacement of distal fragment radial nerve is injured. In posterolateral displacement of distal fragment the median nerve or anterior interosseous nerve is injured. In flexion type ulnar nerve is injured. In closed fractures recovery usually occurs in 2 to 3 months. Perineural fibrosis is the cause for prolonged deficit. Neurolysis is indicated in such patients.

Irreducible fracture with nerve deficit is an indication for open reduction of fracture. Chronic nerve entrapment in callus gives rise to Metev sign i.e., hole in bone.

Iatrogenic injury to ulnar nerve has been reported in 1 to 15% of patients. This occurs when a medial pin is placed. The cubital tunnel is constricted or the nerve is penetrated by the pin. Ulnar nerve subluxation occurs with hyperflexion of elbow predisposes to nerve injury. If nerve injury is documented post operatively the medial pin may be left in place till fracture heals. Also either the medial pin can be replaced in proper position or can be converted to lateral pin construct. Exploration of the nerve is not done routinely.

Iatrogenic injury to ulnar nerve can be avoided by using lateral pins alone or making a mini insertion and avoiding the nerve while applying medial pin and also placing the medial pin 0.5 to 0.75 mm anterior to the nerve. Also by palpating and pushing the nerve posteriorly one can avoid ulnar nerve injury. Extension of elbow places thenerve posteriorlythere by avoiding injury during medial pinning.

## ELBOW STIFFNESS

Loss of motion is more common with open reduction than closed reduction. After pin removal range of motion exercises to be done at home. If it does not increase to near normal at 4 to 6 weeks physical therapy is advised. The causes for loss of motion are posterior angulation, posterior translation and medial rotation of distal fragment.

## PIN TRACK INFECTION

The prevalence of pin track infection varies from 0 to 6.6 %. It is treated with oral or Intravenous antibiotics, pin site care, debridment. Usually pin track infection settles down with pin removal.

## MYOSITIS OSSIFICANS

It is common after open reduction and post operative manipulation.

## NONUNION

It is a rare complication due to infection devasularization and soft tissue loss.

## OSTEONECROSIS

Osteonecrosis of trochlea can occur due to interruption of blood supply. It may be due to the fracture line being very distal or during open

reduction via posterior approach disrupting theposterior blood supply to trochlea leading to fish tail deformity.

**LOSS OF REDUCTION**

It is commonly reported following lateral pins. The pins should engage both fragments, achieve bicortical fixation and pin separation should be greater than 2 mm.

**HYPEREXTENSION**

It occurs due to undercorrection of distal fragment. Children have decreased flexion.

**CUBITUS VARUS**

The gun stock deformity is rare following surgical management. It is commonly due to malunion, can also occur due to osteonecrosis of trochlea or medial portion of the distal humeral fragment. On the anteroposterior view Baumann's angle is decreased. On lateral view there is hyperextension of the distal fragment posterior to anterior humeral line with positive crescent sign i.e. superimposition of capitellum on olecranon.

# MATERIALS

# AND

# METHODS

# MATERIALS AND METHODS

This study was conducted in Rajiv Gandhi Government General hospital attached to Madras Medical College between May 2012 and August 2013. During this period 21 cases of displaced supracondylar fractures of humerus in children were treated with cross pinning and lateral pinning with Kirschner wires according to surgeons preference. The total study population comprised of 21 children.

## INCLUSION CRITERIA

- Displaced supracondylar fractures (Type II, Type III)
- Fractures treated by closed and open reduction
- Age group less than 15 years

## EXCLUSION CRITERIA

Undisplaced fractures (Type I)

Age more than 15 years

A detailed history of mode of injury and initial treatment was obtained from parents and children. The distal neurovascular status was thoroughly examined. Fractures were classified by modified Gartland classification. Cases were done as an emergency or elective procedure

according to surgeons preference and by different surgeons. The availability of C-arm determined the mode of reduction .The pin size used was 1.6 mm in younger children and 2mm in older children. In cases of closed reduction, reduction was checked with C-arm. In case of cross pinning lateral pin was first done in flexion. Precautions were taken to protect ulnar nerveand then medial pinning was done in extension. In case of lateral pinning 2 or 3 Kirschner wires were used depending upon the stability of fracture reduction.

The configuration of kirschner wires (parallel,divergent)was according to surgeons preference.In case of open reduction the triceps was longitudinally split or a tongue shaped incision of triceps was made according to surgeon’spreference. The elbow was immobilized in posterior slab. All patients were examined for distal neurovascular status in immediate post operative period. The above elbow slab and Kirschner wires were removed at 3 to 4 weeks when there was no tenderness at fracture site and after check X-Ray. After this patient was allowed to actively mobilize the elbow without physiotherapy. Check X-Rays were taken at monthly intervals postoperatively.

The following were noted in the postoperative X-Rays for adequacy of reduction.

1. Anterior humeral line

2. Crescent sign

3. Baumanns angle

was measured in immediate post op x ray, and the x ray before k wire removal at three to four weeks. Loss of reduction is determined by change in baumann's angle. The displacement is graded by Skaggs.

| **Displacement** | **Change in Baumanns angle** |
|---|---|
| No | <6 degree |
| Mild | 6-12 degree |
| Major | >12 degree |

Check X-rays were taken when the splint and K wires were removed which helped us to assess union as well as identify any loss of reduction. The patients were followed up at monthly intervals after k wire removal. The cosmetic and functional outcome were assessed using Flynn's criteria.

**GRADING OF RESULTS Modified flynn's criteria**

| Result | Rating | Cosmetic Factor – Loss in carrying angle (in degrees) | Functional – Limitation of elbow flexion (in degrees) |
|---|---|---|---|
| Satisfactory | Excellent | 0-5 | 0-5 |
| | Good | 6-10 | 6-10 |
| | Fair | 11-15 | 11-15 |
| Unsatisfactory | Poor | >15 | >15 |

# RESULTS

# RESULTS

During the period from May 2012 to November 2013 a total of 21 displaced supracondylar humerus fractures in children were operated. Out of 21, in 9(43%) cases cross pinning was done and in12(57%) cases lateral pinning was done.

11 children were males (52%) and 12 children were females(48%). 9(43%) children were under 6 years, 8(38%) children were between 6 to 10 years and 4(19%) children were above 10 years. Mean age was 6.5 years. (range from 6 months to 13years).

11 were left sided (52%) and 12 were right sided(48%) fractures. All patients had a history of fall. 10(48%) children had fall from height. 9(43%) children fell down while playing. 2(09%)children fell down from bicycle.

All patients were extension type injuries and all patients were type 3 by gartland classification

Out of 21 cases, 13(61%) cases were operated by closed reduction and 8 (39%) cases were operated by open reduction. Out of 9 cross pinned cases 8 were operated by closed reduction. Out of 12 lateral pinned cases

4 were operated by closed reduction.

Out of 21cases 17(81%) cases were operated within 1 day and 4(19%) cases were operated after 24 hours and within 1 week due to delayed presentation.(2 cases by cross pinning and 2 cases by lateral pinning). Mean duration between injury and surgery was 1.85 days.

All fractures united by 3 to 4 weeks duration. The mean duration of fracture union was 3.3 weeks.

Out of 21 cases, 14 (66%) patients had limitation of terminal flexion compared with normal contralateral side. Out of 9 cross pinned cases, 4 cases had full range of flexion and 5 cases developed limitation of terminal flexion. Out of 12 lateral pinned cases 2 had full range of flexion 8 cases had flexion loss between 5 to 10 degree 2 cases had flexion loss of more than 10 degrees.

Out of 9 crossed pin cases 4 cases showed no loss of carrying angle and 5 cases showed less than 5 degree loss of carrying angle whereas in lateral pinning 2 cases showed no loss of carrying angle 8 cases showed less than 5 degree loss of carrying angle and 1 case had greater than 10 degree loss of carrying angle 1 case had greater than 15 degree loss of carrying angle. The loss of carrying angle was due to inadequate initial

reduction achieved at the time of surgery. There was no loss of reduction in both initial postoperative radiograph and in the radiograph taken at time of kirschner wire removal.

No patient in cross pinning as well as in lateral pinning group had any loss of reduction.

Out of 9 cross pinned cases 8 cases were treated by closed reduction. one patient developed post operative partial ulnar nerve injury following cross pinning which resolved completely in 3 weeks after Kirschner wire removal. The medial pin was maintained for 2 weeks. Pin removal was done after 2 weeks and above elbow cast was given for 2 weeks. Nerve injury recovered completely.

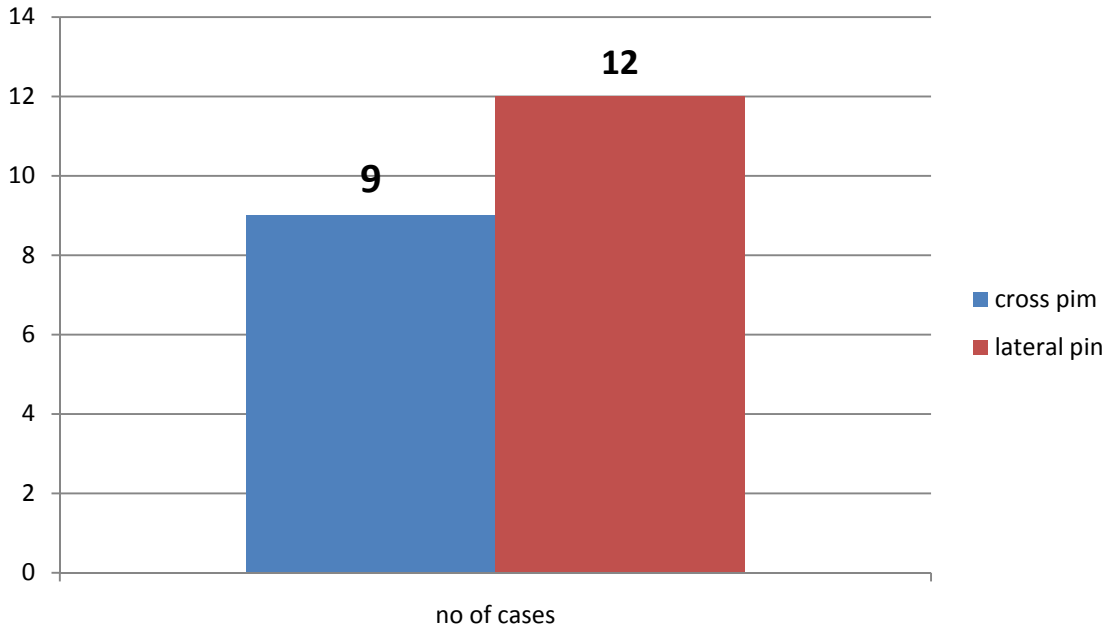
one patient with cross pinning developed pin site infection which resolved with pin removal and oral antibiotics.

No case in both groups developed any vascular injury or compartment syndrome or myositis ossificans or non union.

All 9 cross pinned patients had satisfactory results 4 had excellent and 5cases had good results. All 12 lateral pinned cases had satisfactory results. 2 had excellent results, 8 had good results and 2 had fair results.

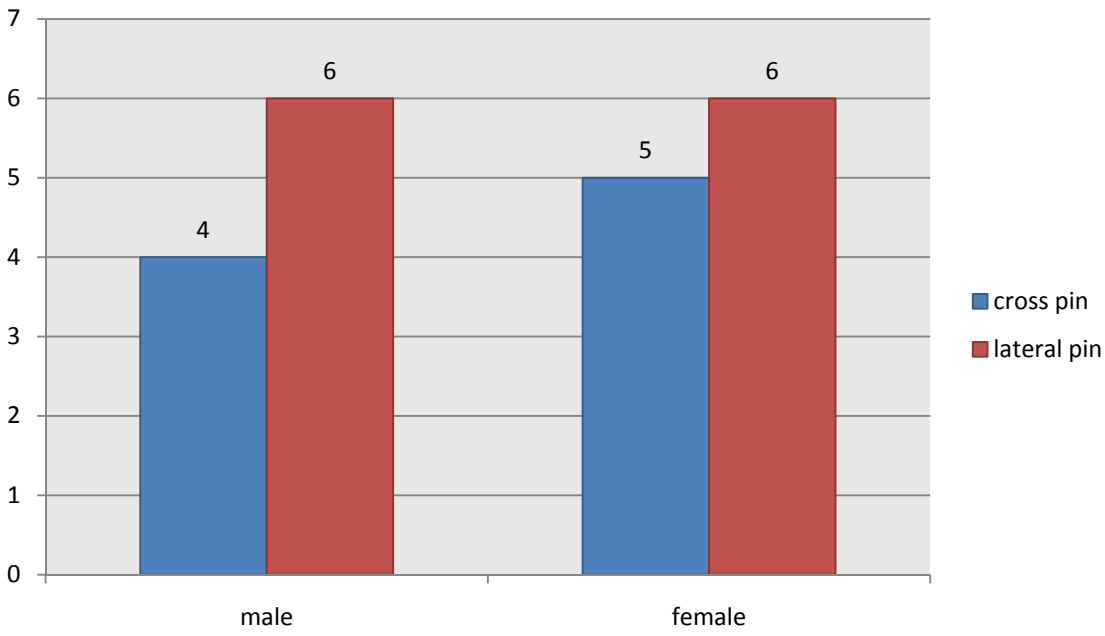
## TABLE SHOWING NUMBER OF CROSS AND LATERAL PINNED CASES

| | Cross pin | Lateral pin |
|---|---|---|
| No of cases | 9 | 12 |



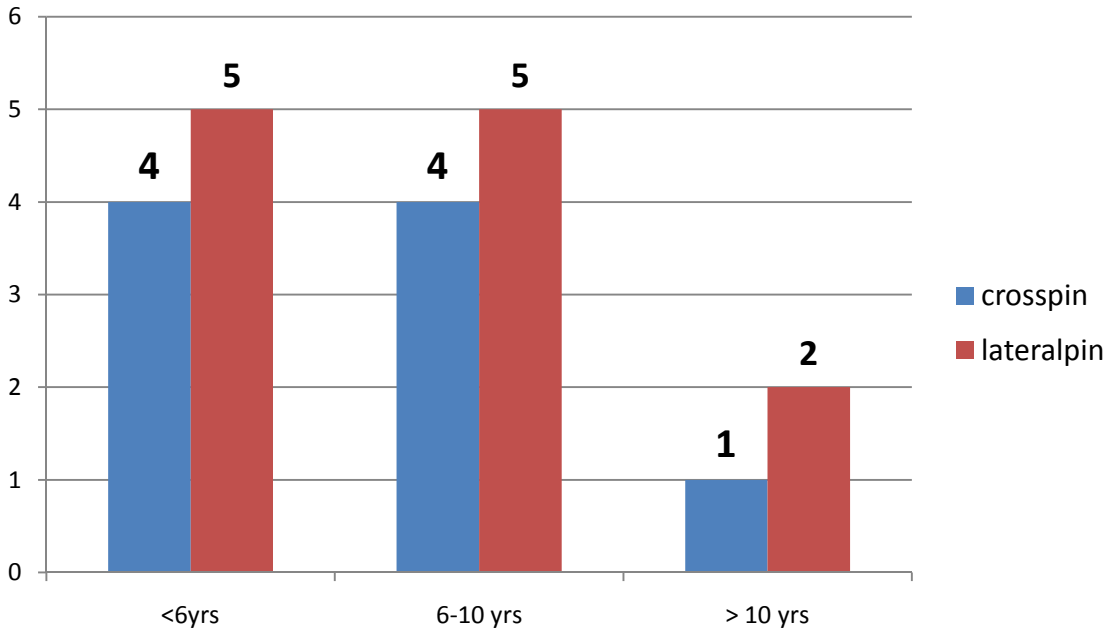
## SEX DISTRIBUTION

| SEX | CROSSPIN | LATERALPIN |
|---|---|---|
| Male | 4 | 6 |
| Female | 5 | 6 |



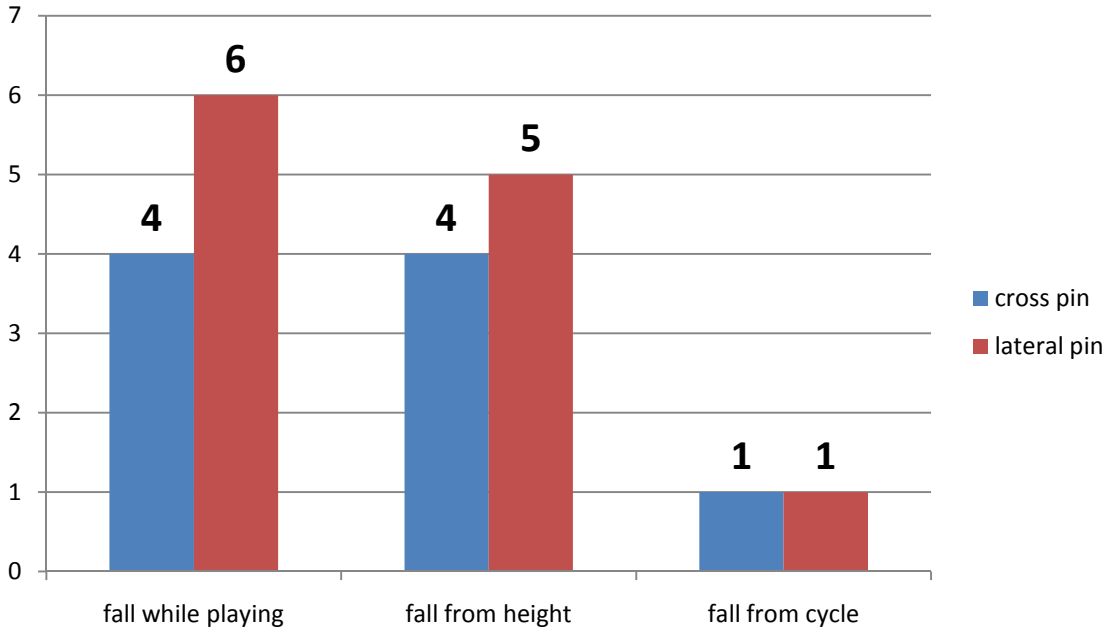
## AGE DISTRIBUTION

| AGE GROUP | CROSSPIN | LATERAL PIN |
|---|---|---|
| < 6YEARS | 4 | 5 |
| 6 – 10 YEARS | 4 | 5 |
| >10 YEARS | 1 | 2 |



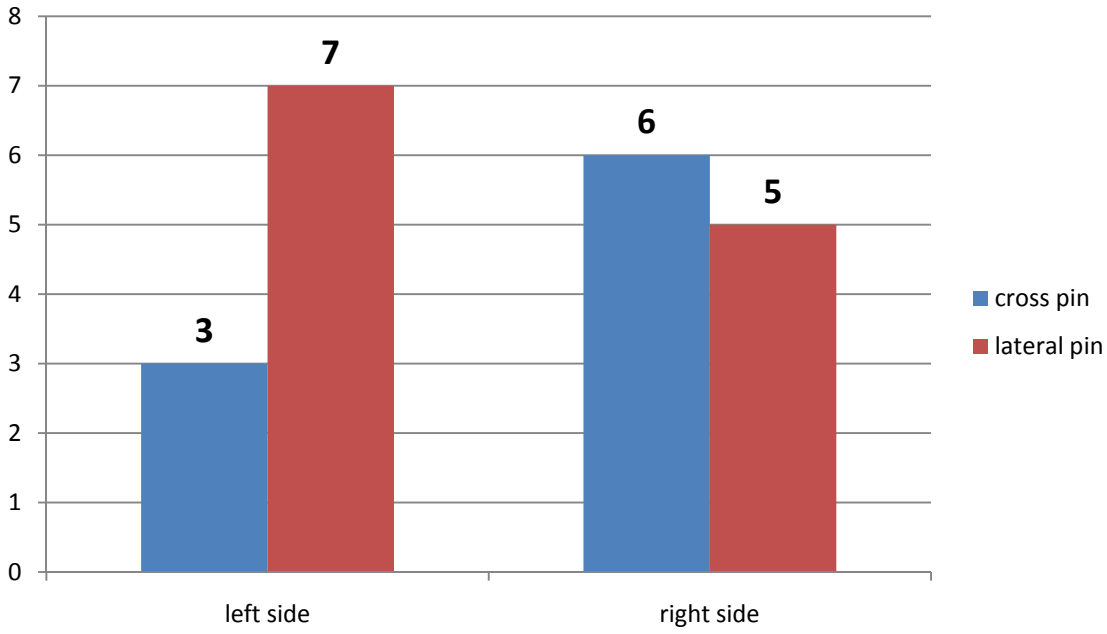
## MODE OF INJURY

| Mode of injury | Cross pin | Lateral pin |
|---|---|---|
| Fall while playing | 4 | 6 |
| Fall from height | 4 | 5 |
| Fall from cycle | 1 | 1 |



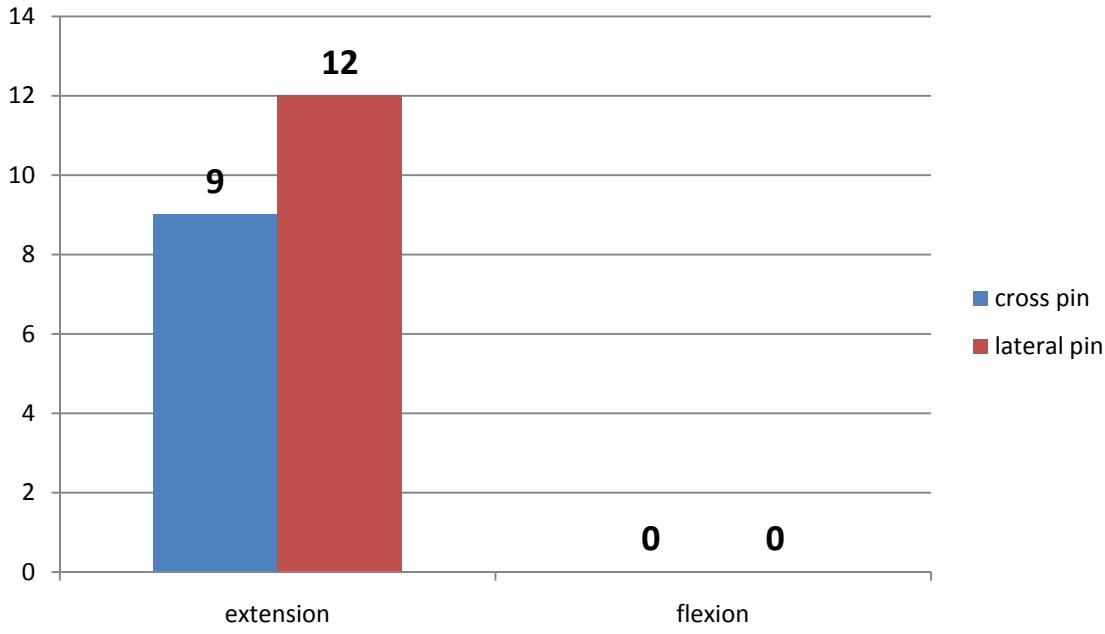
## SIDE DISTRIBUTION

| SIDE | CROSS PIN | LATERAL PIN |
|---|---|---|
| Left | 3 | 7 |
| Right | 6 | 5 |



**TYPE**

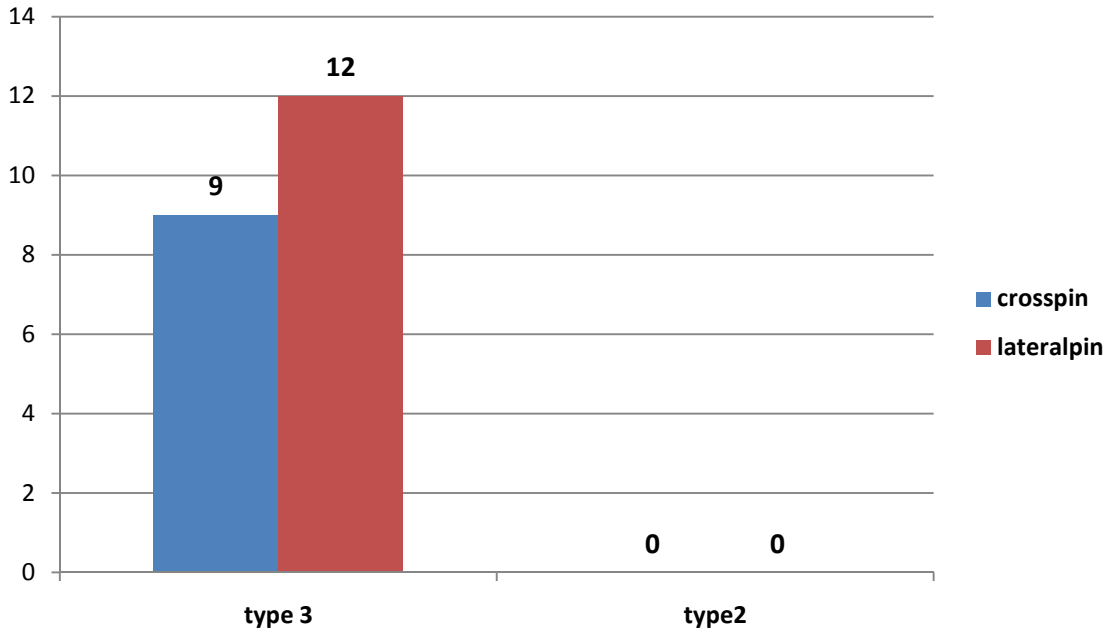
| TYPE | CROSS PIN | LATERAL PIN |
|---|---|---|
| Extension | 9 | 12 |
| Flexion | 0 | 0 |



## GARTLAND CLASSIFICATION OF EXTENSION

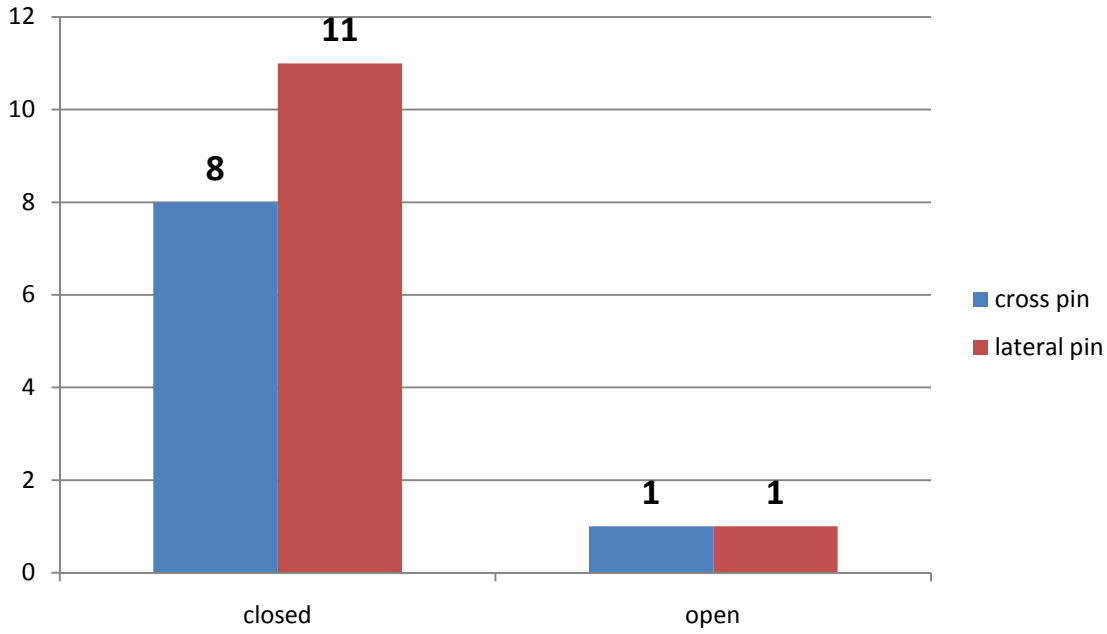
## TYPE FRACTURES

| TYPE | CROSS PIN | LATERAL PIN |
|---|---|---|
| Type III | 9 | 12 |
| Type II | 0 | 0 |



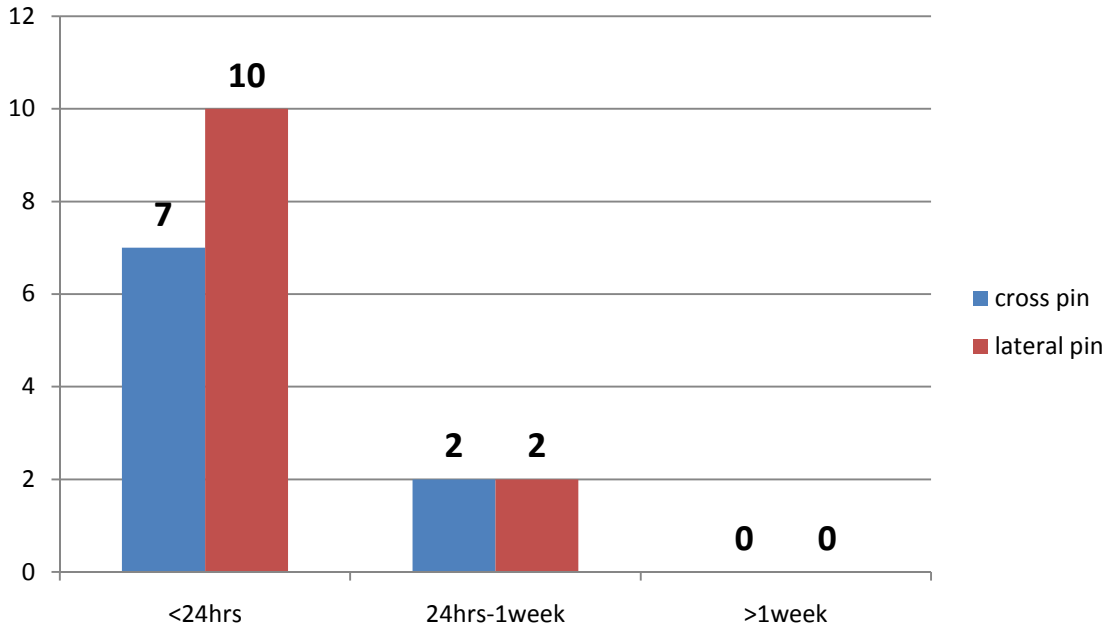
## CLOSED/OPEN FRACTURE

| | Cross pin | Lateral pin |
|---|---|---|
| Closed | 8 | 11 |
| Open | 1 | 1 |



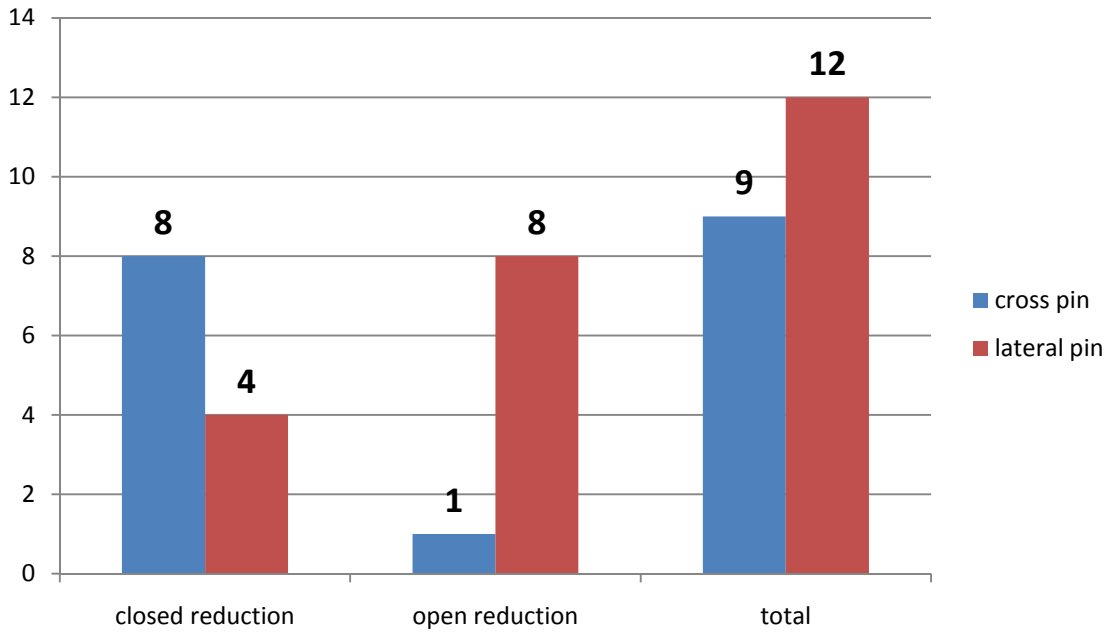
## DURATION BETWEEN INJURY AND SURGERY

| | CROSS PIN | LATERAL PIN |
|---|---|---|
| <24 hrs | 7 | 10 |
| 24 hrs - 1 week | 2 | 2 |
| >1 week | 0 | 0 |



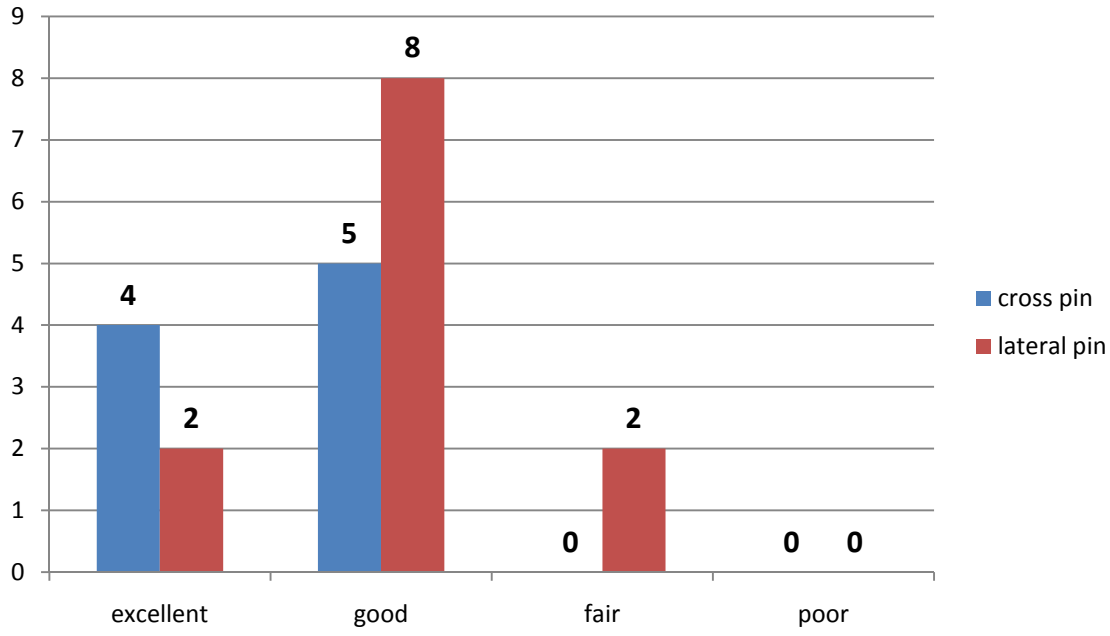
## CLOSED REDUCTION / OPEN REDUCTION

| | CROSS PIN | LATERAL PIN |
|---|---|---|
| Closed reduction | 8 | 4 |
| Open reduction | 1 | 8 |
| Total | 9 | 12 |



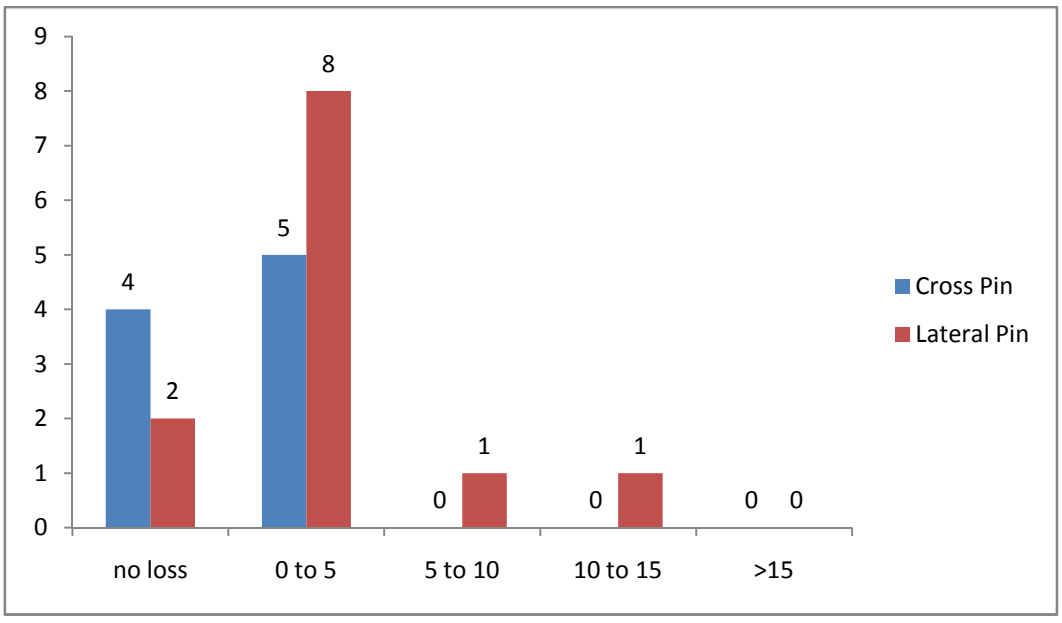
## FLYNNS GRADING OF CROSS & LATERAL PINNED CASES

| GRADING | CROSS PIN | LATERAL PIN |
|---|---|---|
| Excellent | 4 | 2 |
| Good | 5 | 8 |
| Fair | 0 | 2 |
| Poor | 0 | 0 |
| Total cases | 9 | **12** |



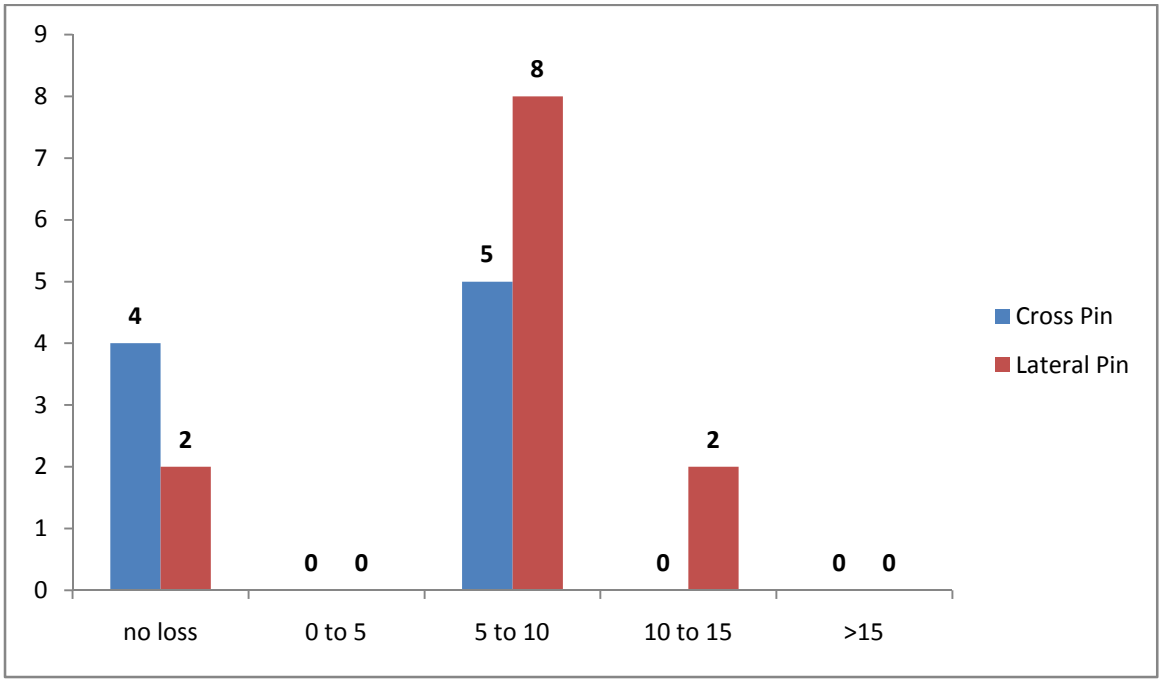
## LOSS OF CARRYING ANGLE IN CROSS PINNING AND LATERAL PINNING

| Range | Cross Pin | Lateral Pin |
|---|---|---|
| no loss | 4 | 2 |
| 0-5 | 5 | 8 |
| 5-10 | 0 | 1 |
| 10-15 | 0 | 1 |
| >15 | 0 | 0 |



## LOSS OF FLEXION IN CROSS PINNING AND LATERAL PINNING

| | Cross Pin | Lateral Pin |
|---|---|---|
| no loss | 4 | 2 |
| 0-5 | 5 | 8 |
| 5-10 | 5 | 1 |
| 10-15 | 0 | 1 |
| >15 | 0 | 0 |



# ILLUSTRATIVE CASES

## ILLUSTRATIVE EXAMPLE - 1

Bharani 2/F




3 weeks FU




Immediate post op

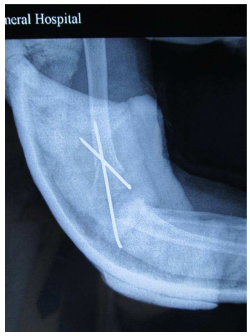
Final FU – 1 year


Excellent result

## ILLUSTRATIVE EXAMPLE - 2

Varsha 2/F

Pre-op


Post-op


3 weeks FU

Final FU – 1 year

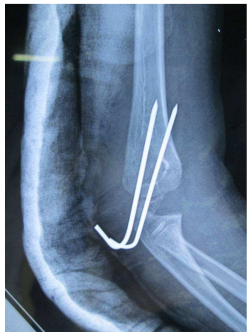
Excellent result

## ILLUSTRATIVE EXAMPLE - 3

Shruthi 6/F


Pre-op


4 weeks FU

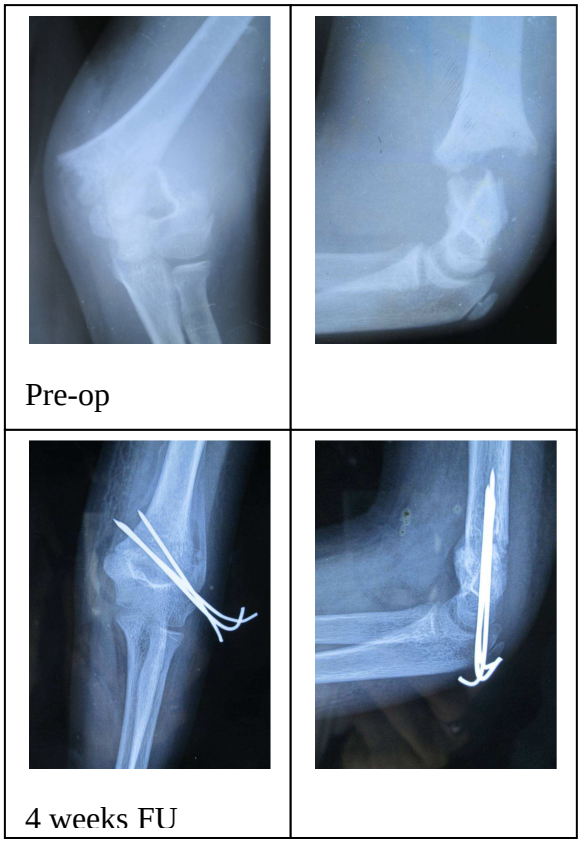
Post-op


Final FU-4 months

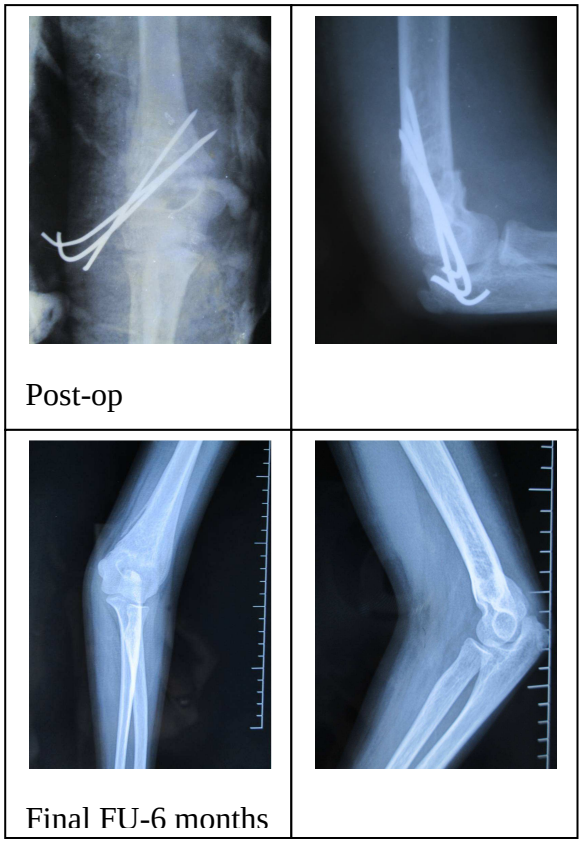

**Good result**

## ILLUSTRATIVE EXAMPLE - 4

Nithyanandhi 11/F



Pre-op



Post-op



4 weeks FU



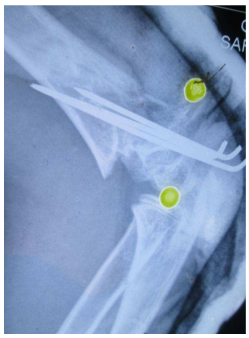
Final FU-6 months

**Good result**

## ILLUSTRATIVE EXAMPLE - 5

Sarath Kumar 13/M

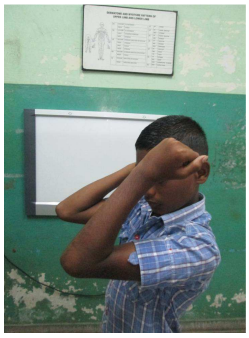
Pre-op



Post-op

4 weeks FU

Final FU-6 months



**Fair result**

# DISCUSSION

# DISCUSSION

The management of displaced supracondylar fracture humerus in children is closed or open reduction and maintenance of the reduction by kirschner wires. The success of surgical treatment depends upon initial accurate reduction and maintenance of reduction till union.

There is a continuing debate regarding best modality of pin fixation of displaced supracondylar humerus fracture in children. The most commonly used treatment methods are crossed medial and lateral pinning and lateral pinning alone.

The advantage of cross pinning is its greatest fracture stability but iatrogenic ulnar injury can occur while placing the medial pin. The advantage of lateral pinning is iatrogenic ulnar nerve injury will not occur, but it is less stable biomechanically.

Biomechanical studies by Hilton et al[16] using adult cadaver and paediatric bone model has found cross pinning provides greater rotational stability than lateral pinning .however by proper site of entry of pin ,the configuration of pin and the number of pins applied via lateral side can also provide equal stability as that of cross pinning.

In our study of 21 patients , cross pinning was done in 9 patients and lateral pinning was done in 12 patients. All patients had satisfactory results according to flynns criteria. Out of 9 cross pinned patients 4 had excellent results and 5 patients had good results. Out of 12 lateral pinned patients two had excellent results, 8 had good results and two had fair results. Though divergent or parallel lateral configuration is advised 2 patients had converging lateral pin configuration in our study and they had good outcome.

Out of 9 cross pinned patients 5 had less than 5 degree loss of carrying angle which was not due to loss of reduction but due to inadequate reduction initially . out of 12 cross pinned patients 8 patients had loss of carrying angle less than 5 degree , 1 patient had loss between 5 to 10 degree and one patient had loss between 10 to 15 degree. This was also due to initial inadequate reduction and not due to loss of reduction. These results were comparable with the study by Foead et al[12] who compared the above two methods of percutaneous pin fixation in displaced supracondylar humerus fractures in children.

Out of 9 crossed pin patients 5 had loss of 5 to 10 degree flexion. Of 12 lateral pinned patients 8 patients had loss of 5 to 10 degree flexion and 2 patients had loss of flexion between 10 to 15 degree. 2 lateral

pinned patients who had flexion loss between 10 to 15 degree was due to inadequate reduction . More number of lateral pinned patients had loss of flexion between 5 to 10 degree when compared to cross pinning group was due to open reduction. 8 out of 9 cross pinned cases was done by closed reduction where as 4 out of 12 cases lateral pinned cases was done by close reduction. This may have led to more loss of flexion in lateral pinning group and not due to configuration of pinning.

There was no loss of reduction in both cross pinning and in lateral pinning group. This was comparable to Skaggs et al[13] who reported no loss of reduction in series of 55 type III fractures treated by lateral pinning. Topping et al and Foead et al[12] also had no loss of reduction in lateral pinning in their series.

In our study we had one case of partial ulnar nerve injury in total of 8 (12.5%) cases of crossed pinning of supracondylar fracture of humerus in children.. Skaggs et al[13] had 8% of ulnar injury in cross pinning group. We did flexion extension method to avoid ulnar nerve injury.In our case ulnar nerve injury recovered completely after 3 weeks duration. We also had no nerve injury in lateral pinned case comparable with skaggs et al[13] study.

# CONCLUSION

# CONCLUSION

1. Cross pinning is the most stable configuration in maintaining the reduction of supra condylar fracture of humerus in children.

2. Lateral pinning is an equally stable configuration in maintaining the reduction of supracondylar fracture of humerus in children .

3. Cross pinning has a definitive risk iatrogenic ulnar nerve injury in spite of taking precautions to protect the nerve.

4. Lateral pinning is a safer procedure to avoid iatrogenic ulnar nerve injury in supracondylar humerus fracture management in children .

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# BIBLIOGRAPHY


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# ANNEXURE

# PROFORMA

**PROFORMA**

# OUTCOME ANALYSIS OF CROSS PINNING VERSUS LATERAL PINNING IN SUPRACONDYLAR FRACTURE OF HUMERUS IN CHILDREN

## PATIENT'S CHART

Name : Age : Sex :

Father's/Mother's/Guardian's Name :

Address : Phone :

Date and time of injury : Side : Right/Left

Mode of injury : Fall while playing/Fall from height/Direct injury/RTA

Whether any treatment taken initially elsewhere :

Date and time when brought to RGGGH :

Distal vascular status on admission :

Radial pulse : Normal / Feeble / Absent
Capillary refilling of fingers : Normal / Delayed
Voluntary finger extension : Possible / Not possible
Forearm pain on passive extension of fingers : Absent / Present

Distal neurological deficit on admission :

Radial nerve / Posterior interosseousnerve : Present (partial / complete) / absent Median nerve / Anterior interosseousnerve : Present (partial / complete) / absent Ulnar nerve : Present (partial / complete) / absent

Fracture closed/open
"Pucker sign" : Absent / Present

Other skeletal injuries :

X-ray : Extension / flexion type
Gartland : III / II

Date and time of reduction :

Check X-ray :

Distal neurovascular status after closed reduction :

Mode of treatment of other skeletal injuries :

**SURGICAL TREATMENT**

Name of the procedure :

Date/ Time/ Duration :

Surgeons :

Position :

Closed / open reduction :

Open reduction : Ulnar nerve –Not identified /Identified / isolated and mobilized

Triceps : Longitudinal splitting / Tongue-shaped insicion

Number of K wires :

Configuration of K wires :

**POST OPERATIVE**

X-Ray

Crescent sign : Absent / Present

Anterior humeral line passes : through middle third / infront of ossification centre of capitellum

Baumanns angle

k-Wires : Number –
Configuration –
Pins cross - mm above the fracture site
Others –

Post operativeperiod : Eventful / uneventful
Wound infection : yes / no
Other details

Post operative distal neurovascular status :
Ulnar nerve palsy : Present (Partial/complete) / absent
Others :

**3-4 WEEKS FOLLOW UP (WHEN KIRSCHNER WIRE AND ABOVE LBOW SLAB REMOVED)**

Date :

Right Left

Active range of movement elbow :

Carrying angle (if full extension possible ) :

Baumanns angle

Distal neurological status :

Pin site infection :

Check X-ray : Any loss of reduction :

**MONTHLY FOLLOW UP**

Date :

Right Left

Active range of movement elbow :

Carrying angle (if full extension possible ) :

Distal neurological status :

Other details :

# INFORMATION SHEET

# PATIENT INFORMATION SHEET

TITLE OF THE STUDY : **Outcome Analysis of Cross Pinning Versus Lateral Pinning in Supracondylar Fracture of Humerus in children.**

We are conducting a study on **"OUTCOME ANALYSIS OF CROSS PINNING VERSUS LATERAL PINNING IN SUPRACONDYLAR FRACTURE OF HUMERUS IN CHILDREN"** among patients admitted in the Institute of Orthopaedics & Traumatology, Rajiv Gandhi Government General Hospital, Chennai.

The purpose of this study is to evaluate and analyse the clinical, radiological and functional outcome analysis of cross pinning versus lateral pinning in supracondylar fracture of humerus in children.

We are selecting certain cases based on radiographic pattern of supracondylar fracture in children and if you are found eligible, we perform surgical procedure for the fractured limb by crossed / lateral pinning technique or if you are all already operated for the fracture by the above mentioned technique we will evaluate the outcome of surgery, which in any way do not affect your final report or management.

The privacy of the patients in the research will be maintained throughout the study. In the event of any publication or presentation resulting from the research, no personally identifiable information will be shared.

Taking part in this study is voluntary. You are free to decide whether to participate in this study or to withdraw at any time; your decision will not result in any loss of benefits to which you are otherwise entitled.

The results of the special study may be intimated to you at the end of the study period or during the study if anything is found abnormal which may aid in the management or treatment.

Signature of Investigator

Signature of Participant

Date :

# CONSENT FORM

# PATIENT CONSENT FORM

| | | |
|---|---|---|
| Study Detail | : | OUTCOME ANALYSIS OF CROSS PINNING VERSUS AND LATERAL PINNING IN SUPRACONDYLAR FRACTURES OF HUMERUS IN CHILDREN |
| Study Centre | : | Rajiv Gandhi Government General Hospital, Chennai. |
| Patient's Name | : | |
| Patient's Age | : | |
| Identification Number | : | |

Patient may check (V) these boxes

a) I confirm that I have understood the purpose of procedure for the above study. I have the opportunity to ask question and all my questions and doubts have been answered to my complete satisfaction. ❑

b) I understand that my participation in the study is voluntary and that I am free to withdraw at any time without giving reason, without my legal rights being affected. ❑

c) I understand that sponsor of the clinical study, others working on the sponsor's behalf, the ethical committee and the regulatory authorities will not need my permission to look at my health records, both in respect of current study and any further research that may be conducted in relation to it, even if I withdraw from the study I agree to this access. However, I understand that my identity will not be revealed in any information released to third parties or published, unless as required under the law. I agree not to restrict the use of any data or results that arise from this study. ❑

d) I agree to take part in the above study and to comply with the instructions given during the study and faithfully cooperate with the study team and to immediately inform the study staff if I suffer from any deterioration in my health or well being or any unexpected or unusual symptoms. ❑

e) I hereby consent to participate in this study. ❑

f) I hereby give permission to undergo detailed clinical examination, Radiographs ,blood investigations and surgical procedure as required. ❑

Signature/thumb impression of the Parent

Signature of Investigator:

Study Investigator's Name: **Dr. SENTHIL KUMAR**

Patient's Name and Address:

# ETHICAL COMMITTEE REPORT

**INSTITUTIONAL ETHICS COMMITTEE**
**MADRAS MEDICAL COLLEGE, CHENNAI- 600 003.**

EC Reg. No. ECR/270/Inst/TN/2013
Telephone No: 044-25305301
Fax: 044- 25363970

# CERTIFICATE OF APPROVAL

To
**Dr.R.Senthil Kumar,**
Post Graduate in MS Orthopaedics,
Institute of Orthopaedics & Traumatology,
Madras Medical College, Chennai-3.

Dear **Dr.R.Senthil Kumar,**

The Institutional Ethics Committee of Madras Medical College, reviewed and discussed your application for approval of the proposal entitled **"Outcome Analysis of Cross Pinning Versus Lateral Pinning in Supracondylar Fractures of Humerus in Children"** No.25122013

The following members of Ethics Committee were present in the meeting held on 11.12.2013 conducted at Madras Medical College, Chennai-3.

| | | |
|---|---|---|
| 1. | Dr.G.Sivakumar, MS FICS FAIS | --- Chairperson |
| 2. | Prof.B.Kalaiselvi, MD<br>Vice Principal, MMC, Ch-3 | --- Member Secretary |
| 3. | Prof.Ramadevi,<br>Director i/c, Instt. of Biochemistry, Chennai | --- Member |
| 4. | Prof.P.Karkuzhali, MD.,<br>Prof.Instt. of Pathology, MMC, Ch-3 | --- Member |
| 5. | Thiru.S.Govindasamy, BA., BL., | --- Lawyer |
| 6. | Tmt.Armold Saulina, MA MSW | --- Social Scientist |

We approve the proposal to be conducted in its present form.

Sd/Chairman & Other Members

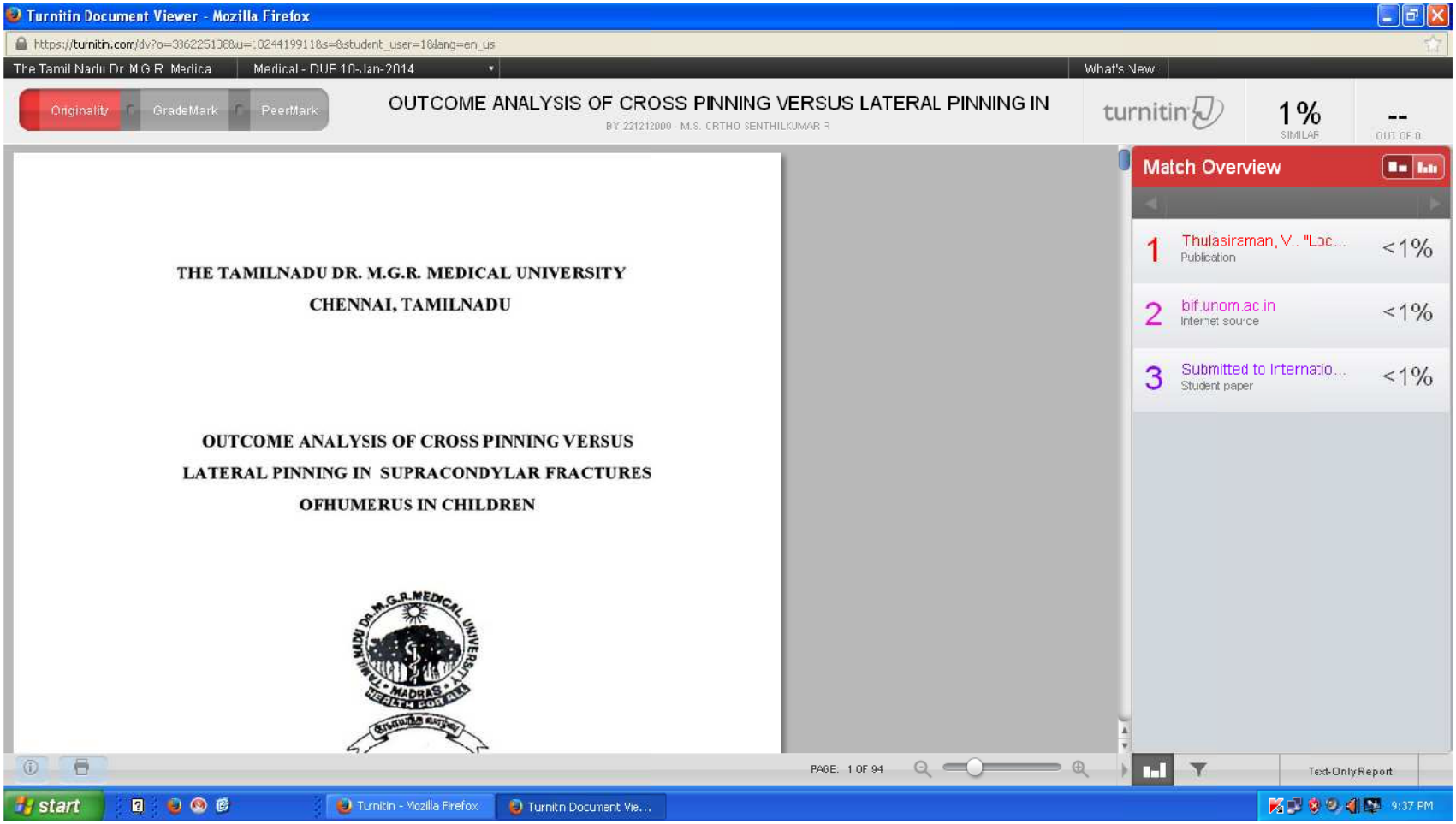
The Institutional Ethics Committee expects to be informed about the progress of the study, and SAE occurring in the course of the study, any changes in the protocol and patients information/ informed consent and asks to be provided a copy of the final report.

15.12.13

Member Secretary, Ethics Committee

MEMBER SECRETARY
INSTITUTIONAL ETHICS COMMITTEE
MADRAS MEDICAL COLLEGE
CHENNAI-600 003

# PLAGIARISM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| E-mail | drrsktvm@gmail.com |
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THE TAMILNADU DR. M.G.R. MEDICAL UNIVERSITY CHENNAI, TAMILNADU OUTCOME ANALYSIS OF CROSS PINNING VERSUS LATERAL PINNING IN SUPRACONDYLAR FRACTURES OFHUMERUS IN CHILDREN Dissertation submitted for M.S. Degree (Branch – II – Orthopaedic Surgery) APRIL – 2014 CERTIFICATE This is to certify that this dissertation titled "Outcome Analysis of Cross pinning versus Lateral pinning in Supracondylar Fractures of Humerus in Children"is a bonafide record of work doneby DR.R.SENTHIL KUMAR, during the period of his Post graduate study from May 2012 to November 2013 under guidance and supervision in the INSTITUTE OF ORTHOPAEDICS AND TRAUMATOLOGY, Madras Medical College and Rajiv Gandhi Government General...

# MASTER CHART

| S.no | Name | Age | Sex | Side | Gartland type | Mechanism of injury | Neurovascular injury | Injury surgery interval | Cross/lateral pinning | PostOPneurologicalstatus | Wound/pin infection | K-wire/AE slab removal | Final followup duration | Loss of carrying angle-deg | Loss of terminal flexion-deg | Distal neurological status | Flynn's criteria |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Bharani | 2 | F | R | 3 | H | A | 1 | CP | - | - | 3 | 12 | 0 | 0 | - | E |
| 2 | Ravi Teja | 9 | M | L | 3 | H | A | 1 | CP | - | - | 3 | 4 | 0 | 0 | - | E |
| 3 | Varsha | 2 | F | R | 3 | H | A | 1 | CP | - | - | 3 | 12 | 0 | 0 | - | E |
| 4 | Sandhya | 4 | F | R | 3 | P | A | 2 | CP | - | - | 3 | 4 | 0 | 0 | - | E |
| 5 | Karthik | 9 | M | L | 3 | P | - | 1 | CP | - | - | 3 | 4 | 5 | 10 | - | G |
| 6 | Abi | 12 | F | R | 3 | C | - | 6 | CP | + | + | 2 | 4 | 4 | 10 | R | G |
| 7 | Buvaneswar | 8 | M | R | 3 | H | - | 5 | CP | - | - | 3 | 4 | 4 | 10 | - | G |
| 8 | Gokul | 4 | M | R | 3 | P | - | 1 | CP | - | - | 4 | 4 | 5 | 10 | - | G |
| 9 | Srinivasan | 9 | M | L | 3 | P | - | 1 | CP | - | - | 3 | 4 | 4 | 10 | - | G |

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10 | Sachin | 10 | M | L | 3 | P | - | 3 | LP | - | - | 3 | 4 | 4 | 10 | - | G |
| 11 | Nithyan | 5 | M | r | 3 | H | - | 1 | LP | - | + | 4 | 4 | 5 | 10 | - | G |
| 12 | Nityanandhi | 11 | F | L | 3 | P | - | 1 | LP | - | - | 4 | 6 | 5 | 10 | - | G |
| 13 | Sarathkumar | 13 | M | L | 3 | C | - | 1 | LP | - | - | 4 | 6 | 5 | 15 | - | F |
| 14 | Shruthi | 6 | F | R | 3 | H | - | 1 | LP | - | - | 4 | 4 | 5 | 10 | - | G |
| 15 | Sudeepkumar | 4 | M | R | 3 | H | - | 1 | LP | - | - | 4 | 4 | 8 | 10 | - | G |
| 16 | Keerthiga | 5 | F | L | 3 | H | - | 3 | LP | - | - | 3 | 4 | 4 | 10 | - | G |
| 17 | Pragalya | 5 | F | L | 3 | P | - | 1 | LP | - | - | 4 | 4 | 12 | 15 | - | F |
| 18 | Shakthipriya | 6 | F | R | 3 | P | - | 5 | LP | - | - | 4 | 4 | 4 | 10 | - | G |
| 19 | Varshini | 6 | F | L | 3 | P | - | 1 | LP | - | - | 3 | 12 | 0 | 0 | - | E |
| 20 | Manjunathan | 8 | M | L | 3 | P | - | 1 | LP | - | - | 3 | 6 | 0 | 0 | - | E |
| 21 | Porchezhiyan | 6/ 12 | M | R | 3 | H | - | 1 | LP | - | - | 3 | 3 | 5 | 10 | - | G |

M – Male F – Female R- Right L – Left H – Fall from Height

C – Fall from Cycle P – Fall while playing CP – Cross Pinning LP – Lateral Pinning E – Excellent

G-Good F-Fair P-Poor R-Recovered